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Final

Central Florida Phosphate Industry

Volume I

Impacts of Proposed Action

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FINAL AREAWIDE ENVIRONMENTAL IMPACT STATEMENT

CENTRAL FLORIDA PHOSPHATE INDUSTRY

VOLUME I

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV
ATLANTA, GEORGIA 30308

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NOVEMBER, 1978
DATE

FINAL AREAWIDE ENVIRONMENTAL IMPACT STATEMENT

CENTRAL FLORIDA PHOSPHATE INDUSTRY

VOLUME I

IMPACTS OF PROPOSED ACTION

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SECTION 1

PUBLIC POLICY ISSUES AND REGULATORY AUTHORITIES BEARING ON THE PROPOSED ACTION

A. PUBLIC POLICY

There has been a growing and substantial public concern regarding the development of phosphate resources in central Florida and the impact that development might have on the state and its citizenry. In a series of discussions, the President's Council on Environmental Quality (CEQ) - together with officials of the Departments of the Interior and Agriculture, Environmental Protection Agency, and the Corps of Engineers - solicited from representatives of the state, local governments, and the phosphate industry their various views and concerns. On the basis of these meetings and other discussions with the federal agencies, it was learned that there is and will continue to be considerable direct federal involvement in the activities of the phosphate industry in central Florida. Most if not all of these federal actions will have potentially significant environmental impacts in the area not only in the counties in which phosphate mining will take place but also in adjacent jurisdictions outside the mining areas.

It was concluded that the most useful and manageable way to analyze the cumulative, interrelated impacts of the present and proposed phosphate development in central Florida is through a comprehensive regional environmental assessment and impact statement that relies primarily on existing information and studies regarding development of phosphate resources.

B. PUBLIC PARTICIPATION

Because of the substantial public interest, the Environmental Impact Statement (EIS) was developed with continuous public participation, which greatly exceeded requirements for EIS preparation. Public meetings were held at the initiation, during, and near the end of the development of the EIS so the public would be apprised of information development and the EIS developers could obtain input regarding special areas of public interest. Also, the public was informed of progress through 11 newsletters mailed to more than 300 citizens and interest groups. During development of the DEIS, working papers on each of 12 tasks and some of the more important subtasks were prepared and sent to repositories in Bartow, Bradenton, Lakeland, and Tampa where they were available for review by interested citizens.

As an adjunct to public participation and preparation of the working papers, an advisory committee representative of local government, the Southwest Florida Water Management District, the industry, and environmentalists was formed to receive each of the working papers for review and comment. The members held seven meetings during development of the EIS.

An interagency Steering Committee representative of eight federal agencies and the state of Florida also was formed for the primary purposes of providing major policy decisions during development of the DEIS and assisting interagency coordination.

C. REGULATORY AUTHORITIES

The National Environmental Policy Act of 1969 (NEPA), 16 USC 4321 et seq., implemented by Executive Order 11514 of March 5, 1970, and the Council on Environmental Quality's (CEQ's) guidelines of August 1, 1973, requires that all federal agencies prepare detailed Environmental Impact Statements on proposals for legislation and other major federal actions significantly affecting the quality of the human environment. The objective of NEPA is to build into agency decision-making an appropriate and careful consideration of all environmental aspects of proposed actions, explanation of potential environmental effects of proposed actions and their alternatives for public understanding, avoidance or minimization of adverse effects of proposed actions, and restoration or enhancement of environmental quality.

Section 511(c)(1) of the Federal Water Pollution Control Act as amended (FWPCA) (PL 92-500) requires that NEPA apply to the issuance of a permit under 402 of FWPCA for the discharge of any pollutant by a new source as defined in 306 of FWPCA. Proposed regulations for applying NEPA to the issuance of new-source National Pollutant Discharge Elimination System (NPDES) permits were published in the Federal Register on October 9, 1975, Part VI. Issuance of EPA NPDES new-source permits for new-source mining and processing in the study area was delayed during the preparation of the environmental impact statement. Existing mining and processing have continued, however, and generally should not be affected by the issuance or non-issuance of new-source NPDES permits.

These EPA regulations provide for the preparation of an EIS, in which a number of actions that will occur in a limited time span and in the same general geographic area are taken.

If a proposed phosphate mining operation involves placement of fill or discharge of dredged material in any of the following, a Department of the Army permit is required:

- Streams that have flows of 5 cubic feet per second or more or wetlands that are adjacent to such streams. (Wetlands are defined as areas in which periodic inundation occurs. They are characterized by vegetation that requires saturated soil for growth and reproduction.)

- Natural lakes that are 5 acres or larger
- Artificial lakes formed from impounding waterways that have flows of 5 cubic feet per second or more
- Coastal areas and their adjacent and contiguous wetlands

Authority for the Department of the Army program to regulate placement of fill and discharge of dredged material in waterways or wetlands is contained in Section 404 of the Federal Water Pollution Control Act of 1972.

The district engineer also may exercise his discretionary authority and assert jurisdiction over waterways that have flows of less than 5 cubic feet per second and any wetlands (including perched wetlands) if such action is warranted because of water quality considerations.

In instances in which phosphate mining affects the course, location, condition, or capacity of navigable waters of the United States (defined as waterways used by commerce in the past or present or could reasonably be used by commerce in the future or waterways whose navigation has been improved with federal funds), a Department of the Army permit under Section 10 of the River and Harbor Act of 1899 would be required. All areas subject to the ebb and flow of the tides are considered navigable waters of the United States.

Though almost all phosphate reserves lands in west central Florida are privately owned, another authority that may be utilized governs phosphate deposits on public-domain lands and those reserved to the U.S. in patented lands, all of which are leased under the authority of the Mineral Leasing Act of 1920, 30 USC, Section 181 et. seq. Phosphate deposits on acquired lands are leased under the Mineral Leasing Act for Acquired Lands of 1947, 30 USC, Section 351-359. Rules and regulations necessary to carry out the provisions of both acts are prescribed by the Secretary of the Interior and administered by the Bureau of Land Management.

The authority of the Secretary of the Interior pertaining to phosphate leasing is contained in 43 CFR, Group 3500 (Leasing of Minerals Other Than Oil and Gas). Regulation 43 CFR, Part 23, protects nonmineral resources during operations for discovery and development of minerals under permits and

leases issued under the Mineral Leasing Act of 1920. A technical examination of prospective surface exploration and mining operations must be made. On the basis of this examination, special stipulations to assure protection of non-mineral resources and the environment are incorporated into the permit or lease. On lands administered by agencies other than the Department of the Interior, the administering agency must be contacted for its recommendations.

SECTION 2

PROPOSED ACTION

The following is a scenario of phosphate development which was determined to be as compatible as practicable with other desired and intended land uses in Central Florida. This scenario was developed with the understanding that all local, regional, state, and federal requirements existing at the time of this EIS would also be met.

A. NEW SOURCES

1. Mining and Beneficiation Requirements

- Eliminate the rock-drying process at beneficiation plants and transport wet (6 to 20 percent moisture) rock to chemical plants.

  Only rock to be utilized in triple superphosphate, elemental phosphorus, defluorinated rock feed, or other fertilizer processes requiring dry rock would be dried - and this would be at the chemical processing complex or at dryers permitted by DER prior to publication of the DEIS. A possible exception on a case-by-case basis could be made for rock to be shipped outside of Florida for chemical processing; if the energy for transporting the moisture were greater than the energy saved by eliminating drying, drying at the beneficiation plant would be considered if air quality (including radiation) could be adequately protected.

- Meet State of Florida and local effluent limitations for any discharges.

- Eliminate conventional aboveground slime-disposal areas.

  The mining and reclamation plan for new-source mines should establish a method whereby the slimes (or slimes/tailings mixture) would be used for reclamation or some other purpose. The need for an initial aboveground storage area is recognized - as is the need for small retaining dikes around certain areas reclaimed with a slimes/tailings mixture. If the percentage of waste clay at a mine exceeds the proportionate amount that can be utilized, the incremental amounts beyond that which can be handled by new slime-dewatering methods may be placed in a holding pond for reclamation after adequate settling.

- Meet Southwest Florida Water Management District consumptive-use permit requirements.

- Provide storage that allows recirculation of water recovered from slimes.

  Storage capacity is to be determined during the pending DRI and/or the site-specific EIS based on local hydrologic characteristics. The designed storage capacity should allow for capture of 100 percent of water recovered from slimes for reuse.

- Use connector wells.

  Such wells offer an economical means of dewatering the shallow ground water from the water-table aquifer before mining, while replenishing a portion of the water pumped from the Floridan aquifer for the purposes of transportation and beneficiation. Mining plans for new-source mines can continue to utilize this method of dewatering - but only with the following precautionary measures: maximum utilization of water obtained from dewatering; monitoring by both industry and regulatory agencies to assure that the drained water meets recommended drinking-water criteria chemically, bacteriologically, and radiologically at all times; and assurance that wells will be adequately cemented and grouted before being abandoned.

- Address proposed regulations regarding radiation levels to be published by EPA and projected by mining and reclamation plans for new-source mines based on test borings of material to be encountered. The DRI and/or site-specific EIS should also develop a reclamation plan that considers radiation of spoil material and reduces as much as possible the amount of radionuclide-bearing material left within 3-4 feet of the surface.

- Meet county and state reclamation requirements and include in the DRI and/or site-specific EIS an inventory of types of wildlife habitat in the area to be mined and the area immediately surrounding it.

- The mining and reclamation plan will take into account the protection and restoration of habitat so selected species of wildlife will be adequately protected during mining and reclamation.

- Protect or restore wetlands under the jurisdiction of the Corps of Engineers, Section 404, Federal Water Pollution Control Act, pursuant to 404(b) Guidelines (40 CFR 230).

Three categories of wetlands are to be established in the Mining/Reclamation Plan for New Source Mines for regulation. Category 1, which are to be protected, includes wetlands within and contiguous to rivers and streams having an average annual flow exceeding 5 cubic feet per second as well as other specific wetlands determined to serve essential environmental functions, including water quality. (These are wetlands that provide an essential synergistic support to the ecosystem and that would have an unacceptable adverse impact if they were altered, modified, or destroyed.) This generally includes cypress swamps, swamp forests, wet prairies, and certain freshwater marshes. Category 2 includes wetlands that should be restored as wetlands to perform useful wetland functions. This also includes certain isolated noncategory wetlands that serve a primary function or several minor functions that may be maintained through proper restoration. Category 3 includes wetlands that would not have to be restored as wetlands. These are isolated and normally intermittent in nature, have less significant hydrological functions than Category 2, and minimal life-support value.

- Make efforts to preserve archeological or historical sites through avoidance or mitigate by salvage excavation performed by a professionally competent agency any sites deemed significant by the Florida Division of Archives, History, and Records Management. If mitigation is chosen, the resulting report should be submitted to that state agency for examination and comment.

2. Chemical Processing Requirements

- Meet federal air quality new-source performance standards and design surge capacity in the EPA Standards of Performance for New Sources for process water systems.

- Line gyp ponds with an impervious material unless it can be demonstrated in the site-specific EIS that such lining is unnecessary in protecting ground water from chemical and radiological contamination.

- Recirculate process and non-process water. The non-process system should have the same design surge capacity as required in the Standards of Performance for New Sources for process water systems.

- Provide for recovery of fluorine compounds from phosphoric-acid evaporators unless it is determined at the time of permit application that market conditions are such that the cost of operation (not including amortization of initial capital cost) of the recovery process exceeds the market value of the product. If there is an exception, the site-specific EIS is to contain an estimate of pond-water fluoride concentrations to be attained and levels of fluorine emission. Estimated fluorine emissions from new-source gyp ponds should not cause the plant complex to exceed the total allowable point-source fluorine emissions within the plant complex if a permit is to be issued.

- Encourage recovery of uranium based on economic feasibility data to be included in the site-specific EIS.

3. Additional Considerations

The allowable concentrations for treated effluents do not reflect the need for water quality protection in the Tampa Bay and Peace River Basins nor the capability of 2-stage liming and clarification systems currently in existence in central Florida. The following is a list of the concentrations allowed in the EPA Standards of Performance for New Sources and a recommendation for effluent concentrations on which treatment systems designed for new-source chemical plants should be based:

	Recommended Maximum Concentrations		EPA Standards of Performance	
	24-Hr Max.	30-Day Avg	24-Hr Max.	30-Day Avg
P	30 mg/1	10 mg/1	105 mg/1	35 mg/1
F	30 mg/1	10 mg/1	75 mg/1	25 mg/1
TSS	60 mg/1	20 mg/1		
Ra 226	9 pCi/1	4 pCi/1		
pH	6.0-9.5	6.0-9.5		

Design of treatment systems for new-source chemical plants should reflect the latest available technology at the time the design is initiated. The levels recommended reflect available technology in 1978, which will probably change before design of a new-source chemical plant is initiated.

In addition, the nonprocess water system is to be designed for recirculation with the same design surge capacity as the contaminated process water system. Maximum concentrations for discharges during such rainfall events are to be the same as those for the treated contaminated process water discharges. Continuous discharge of cooling tower and boiler blowdown and other low-volume noncontaminated streams may be allowed if the water cannot be discharged to a mining circuit.

The limitations do not preempt EPA National Effluent Guidelines but are based on protection of water quality in Tampa Bay and Peace River Basin.

Site specific plans by applicants for new source chemical plants are to provide for retiring gypsum disposal and/or process water recirculation ponds. These plans will establish a means for neutralizing and/or insolubulizing chemical and radiological contaminants remaining in the pond at the date of retirement, and to prevent these contaminants from entering the atmosphere, surface water, or groundwater at any future time.

4. Relationship Between Areawide EIS and Site Specific EIS's

The purpose of an areawide or generic EIS is to examine areawide and cumulative short and long term effects of the continued expansion of (in this case) the phosphate industry. The selected scenario incorporates alternatives and mitigative measures to make the proposed expansion as compatible as possible with other desired and intended land uses. Thus, the Areawide EIS establishes a basis for initiating site specific EIS's for new source mining and chemical processing operations. Each site specific EIS will develop a mining and reclamation plan based on Areawide EIS recommendations, and examine effects of the site specific mining and reclamation plan. If the mining and reclamation plan deviates from Areawide EIS recommendations, then justification has to be provided, including a detailed examination of short and long term areawide and cumulative effects of the deviation.

B. EXISTING SOURCES

The EPA, under the rules established for administering the FWPCA as ammended in 1972, has no direct legal authority to change requirements for existing sources, but the following are recommendations resulting from evaluation of information developed during environmental assessment of the alternative scenarios.

1. Process Modifications

It is recommended that existing operations modify processes and control equipment to meet all air emission and water discharge requirements listed for new sources by 1983.

2. Operations and Maintenance

Increased vegetative fluoride levels from 1972 until mid-1977 demonstrates the need for a continuous regulatory program of in-plant inspections, source sampling, and ambient monitoring to assure that the industry continuously operates and maintains pollution-control equipment.

SECTION 3

SUMMARY OF PRIMARY IMPACTS OF THE PROPOSED ACTION

A. INTRODUCTION

The proposed action represents a combination of the alternative scenario ("Permit Existing and New Sources") as modified by parts of Scenarios 2.12 ("Use Process Modification") and 2.14 ("Control Activities in U.S. Waters and Wetlands") as described in Volume II of this FEIS. This allows continued operation of the industry identified as "already permitted" as well as the permitting of new mines (Figure 3.1).

B. NATURAL ENVIRONMENT

1. Atmosphere

The proposed action will have little impact on the air quality in the study area. Sulfur dioxide (SO_2) and dust emissions in Polk County because of drying, grinding, and transportation will decrease as mines in that county are depleted and new mines are opened elsewhere. Other nonphosphate industry sources, however, will offset the decreases. The new mines will ship wet rock, thus preventing the migration of an estimated 1140 metric (1250 short) tons per year of dust and 7090 metric (7800 short) tons per year of SO_2 emissions from dryers in Polk County into adjoining areas. The emissions from existing rock drying will decrease as the dryers are phased out.

Though plans could be revised, the projection of impacts was based on the assumption that no new chemical plants would be built. Consequently, fluorine emissions will not increase. If a new source chemical plant were permitted, it would be required to reduce pond water fluorine concentrations so that New Source Performance Standards are met for the entire plant complex, including the pond.

To simulate the proposed action it has been assumed that the chemical processing part of the phosphate industry will continue to operate at 1976 levels, supplementing domestic rock with imports as the existing mines become depleted. Because of the installation of air pollution control devices during 1976-77, there has been a reduction of industrial emissions independent of any scenario projections; this is most evident in the case of

SO_2 emissions from fulfuric acid plants in Polk and Hillsborough counties. Changes in the emission inventory due to the restraints of this scenario will appear as reductions in dust as mining and drying activities decline. Sulfur dioxide emissions caused by fuel burning in the dryers will also decline as imports replace locally processed rock. Since imports will supplant exports, it is estimated that the dust generated at seaports by movement of phosphate rock and refined products will remain at the same level. Although the ambient SO_2 levels in Polk County will be reduced since no other source categories are predicted to increase enough to totally offset the decreases at the phosphate plants, the county's particulate levels (and both SO_2 and particulates in all other counties in the study area) is projected to show a slight rise because of increases by nonphosphate sources.

Adding new mines to replace existing capacity will tend to keep constant the phosphate industry's areawide pollutant load on the atmosphere after 1977. Some of the emissions associated with mining, drying, and transporting will shift slightly south as these activities move into Manatee, Hardee, and DeSoto counties. Air emissions created by sources other than the phosphate industry will dominate the inventory in Hillsborough, Manatee, and DeSoto counties so that any changes in air quality will be difficult to associate with the phosphate industry. Sulfur dioxide levels in Polk County should slightly decrease as some of the rock dryers are phased out. Hardee County will exhibit an increase in air pollution due to the industry move into Hardee. Sarasota and Charlotte counties should not be materially affected by air emissions from the phosphate industry.

The emission inventory for the proposed action is that listed for Scenario 2.11 in Volume II. Changes from the "Without Action" inventory will be primarily in mining, storage/transportation, and drying, reflecting the movement of these activities from Polk County into Hillsborough, Manatee, Hardee, and DeSoto counties.

2. Land

a. Physical Environment

1) Unique Physical Features

In terms of potential impact of actions by the phosphate industry, the karst structures in the Hawthorn limestone underlying the phosphate ore zone of the area are of interest. The primary effects on these features are expected to be collapse or high-volume drainage caused by excessive surface loading and increased hydrologic head created by abovegrade storage of clay slimes and waste gypsum. The amount or distribution of the waste-gypsum stacks for this scenario are not expected to differ from those for the "Without Action" alternative, so interest is focused on the new clay-slime impoundments forecast under this scenario; it is estimated that an additional 3561 hectares (9900 acres) will be committed to slime impoundments from 1977 through 1985 and an additional 11,858 hectares (29,300 acres) from 1977 through 2000. Under Scenario 2.11' ("Industry's Projections"), additional areas committed to slime ponds are expected to approximate 3561 hectares (8800 acres) in the short term and 20, 883 hectares (51,600 acres) in long term.

Because the precise locations of karst features underlying the proposed additional mines and detailed information regarding lines of weakness are not known, the character of the limestone underlying proposed temporary slime-storage areas should be investigated on a site-specific basis to assess the precise potential for impact.

The natural physical features of the study area include the sand terraces, geologic ridges (e.g., the Lake Wales ridge), solution cavities (sinkholes) and partings of the surface and subsurface, and other minor features typical of flat, low-lying terrain. Of these, the slime ponds and gypsum stacks do not affect the ridges per se, they potentially effect sinkhole development and collapse. Large clay-slime storage impoundments and stacking of waste gypsum load the surface, leading to high volume drainage into groundwater aquifers with the attendant potential for contamination of those groundwaters. Also, these storage and stacking practices may cause collapse of solution cavities.

2) Soil

The 7-county study area has approximately 453,264 hectares (1.12×10^6 acres) of mapped soil association containing soil types rated high in their potential to produce truck crops or citrus, which represents approximately 28 percnet of the study area. Under the proposed action, destruction of approximately 6625 hectares (16,370 acres) of these soil associations is forecast for 1977 - 1985 and 12,906 hectares (31,890 acres) for 1977 - 2000. These figures represent 1.5 and 2.8 percent, respectively, of the total high-potential associations in the study area and, compared with the "Without Action" scenario, an increase in the destruction of high-potential soils (relative to the total area) of 0.4 percent (1.1 versus 1.5 percent) for the near term and 0.9 percent (1.9 versus 2.8 percent) for the long term. Based on these percentages, the impact of this scenario on the destruction of high-potential soils, compared with the "Without Action" alternative, is considered insignificant. The percentage changes (the proposed action "Without Action") relative to the total area are 0.4 percent (1.1 versus 1.5 percent) and 1.4 percent (1.9 versus 3.3 percent) for the respective time periods.

The phosphate industry activity that primarily affects soil is mining: it destroys soil in terms of its original identification characteristics. Under the proposed action, it is estimated that more than 4850 hectares (12,000 acres) of soil associations rated as potentially well suited for agriculture will be disrupted by mining from 1977 through 1985, and more than 8500 hectares (21,000 acres) from 1977 through 2000. Once reclamation replaces the soil materials, however, new soils will develop that may be better suited for certain agricultural purposes such as pasture, because of improved moisture-holding capacity and permeability and the absence of underlying clay pans.

3) Exposure

The Proposed Action assumes that an additional seven mines will be in operation through 2000, representing an increase of 41 percent numerically over the "Without Action" alternative. Mining plans for six of these imply significant knowledge of the geologic section in the areas, and it is assumed that information from prospect drilling is available also for the seventh location. Thus, the additional information that mining (excavating) would provide by exposing the geologic section is expected to be insignificant.

In contrast to these mines, which are in some stage of permitting, the results of a land use questionnaire sent to phosphate companies having interests in central Florida showed a total of 19 mines would be in operation between now and the year 2000, in addition to the 18 already in operation. In this extreme extension of the proposed action, (the "industry view"), 12 new mines (excluding one scavenger operation) are forecast in addition to those simulated under Scenario 2.11 (see Volume II); all are expected to come on line between 1985 and 2000. Compared to the "Without Action" scenario, the "industry view" represents an increase of 112 percent numerically in lands affected. Geological section information needed to prepare for these additional mines will constitute a significant, though unquantifiable, addition to current knowledge, especially in terms of phosphate reserves and resources for these areas.

Industry activities that result in information about the geologic section, including its stratigraphy and geochemistry, are a positive impact. Principal among the activities are drilling and excavation. Under this scenario, these activities will continue through 1985, but will essentially cease by the year 2000.

4) Topography

Land excavation, material and waste storage, and the earthern structures associated with these activities impart primary effects on topography. Land excavation predominates. The proposed action, compared with the "Without Action" alternative, is expected to add 7160 mined hectares (17,600 acres) from 1977 through 1985 and 23,810 hectares (58,500 acres) from 1977 through 2000, representing an increase of 35.8 and 72.6 percent, respectively. However, comparing area increases to the total study area (an estimated 1.6×10^6 hectares [4.0×10^6 acres]), the differences are 0.4 and 1.5 percent for the respective time periods. Because of these low net percentage changes, this scenario's impact on topography is considered insignificant in both the short and long terms. Under the "industry view" the net percentage changes would be 0.4 and 2.6 percent respectively.

Topographical effects (changes in natural surface contours) will be caused primarily by excavations to remove phosphate ore. Estimates of the surface area to be mined under this scenario are 19,870 hectares (49,100 acres) from 1977 through 1985 and 32,619 hectares (80,600 acres) from 1977 through 2000. However, reclamation will restore these lands to nearly their original contours.

5) Radiation

Under the proposed action radiation levels at the chemical processing plants should remain constant through the year 2000 because of the continued use of locally mined phosphate ore and the constant level of throughput that is forecast. Therefore, industry effects on radiation are keyed to activities at the mining sites. Mining and reclamation increase radiation levels above background. The magnitude has been estimated on the basis of radium-226 radioactivity concentrations in surface materials expected to exist at various stages for a hypothetical mining unit. Based on the conversion factor that an individual will be exposed to 1.85 microroentgens per hour of gamma radiation for each picocurie per gram of radium-226 radioactivity concentration of a surface, the maximum annual dose equivalent for continuous occupancy in the mining pit (an absurd situation) would be less than the guide for the general

population. Occupational guidelines state that employees should not receive a whole-body exposure (external exposure from gamma radiation) of more than 5 rem (5000 millirem) per year or lung exposure (inhaling airborne radionuclides in the form of dust) of more than 15 rem (15,000 millirem) per year. Guidelines for the general population are one-tenth of these values. To date, no activity of the phosphate industry has been proved to cause a radiation dose to the general population in excess of the guideline. Furthermore, when industry average time-weighted values are used, it is anticipated that no phosphate workers will receive doses of radiation exceeding the guideline established for the general population.

Based on the preceding, the impact on the general population and on phosphate workers by the increase in gamma radiation resulting from the forecasted increase in mining activity under the proposed action through the year 2000 would be insignificant compared with the "Without Action" condition.

Since no construction of chemical processing plants or rock dryers is forecast under the proposed action, both the short-term (1977 - 1985) and long-term (1977 - 2000) effects of ongoing industry activity on background radiation will be essentially concentrated in areas scheduled for mining during each of the periods. Exceptions would include the continued accumulation of waste products at the chemical processing plants, continued transportation of mine and processing-plant products, and ongoing construction of dams, levees, and drainage-control systems. The effects of radium-226 radioactivity concentrations in materials associated with industry activities were estimated on the basis of disturbance of surface materials (thus, radium-226 concentrations) resulting from industry activities. Since mining exposes bedclays and residue matrix material in areas where the surface was previously native soil, the potential is to increase the "surface" radium-226 radioactivity concentration from 1.5 picocuries per gram to approximately 50 picocuries per gram. This adverse effect is offset somewhat by backfiling the mining cuts with waste sand tailings (7.5 picocuries per gram) and overburden (10 picocuries per gram, excluding leach-zone material). Areas of cuts dedicated to waste clay-slime impoundments are expected to exhibit very low background radiation while the slime particles (45 picocuries

per gram) are covered with decant waters (1-2 picocuries per liter); however, as these areas dewater, background radium-226 concentrations in the surface material should approach the level given for slime particles. Thus, background radiation in reclaimed mined areas will be higher than it was prior to mining unless original surface material is saved to top-dress both the reclaimed slime ponds and the lands containing the waste sands and overburden. Radiation at chemical processing plants should remain essentially at current levels until imported phosphate rock is needed to maintain production levels; then, background radiation should decrease with increased replacement of local rock by imported rock.

Localized increases in radiation levels may result from implementation of uranium recovery plants (modules). The levels associated with this process should be well within guidelines for radiation workers and, with the implementation of prudent protection measures, well within guidelines established for the general population.

Reduction in radiation levels will occur as dry-rock grinding is replaced with wet-rock grinding and dryers are eliminated. This will lower fugitive dust levels, thus lowering escaping radionuclides, and also result in lower radiation levels in the immediate vicinity of the grinders and the eliminated dryers. Based on data gathered at a Polk County dryer that was processing Polk County phosphate rock (USEPA 1977), emissions of 64.5 tons per year of particulates contained 24.5×10^8 picocuries per year of radium-226; the maximum potential lung dose outside the plant proper (i.e., 400 meters from the dryer) was 48 millirems per year.

6) Noise

Increased mining activities under the proposed action will increase ambient noise levels in the immediate vicinity of operating engines or machinery (e.g., bulldozers, draglines, and washing/beneficiation plants). These increases will not impact the general population, and employees may be readily protected from these noises.

Phosphate mining does not create noise levels high enough to represent an undesirable effect on area population not associated directly with the industry, but ambient noise levels increase locally during mining and reclamation, especially in the immediate vicinity of bulldozers and draglines that are in operation. However, operations personnel can be easily protected from noise through administrative or engineering controls or the use of protective equipment, and noise levels will consistently decline with the phase-out of mining.

7) Miscellaneous

Lining waste-gypsum stacks and cooling-water ponds at new chemical processing plants is expected to reduce seepage into the underlying strata. Because of the neutralizing characteristics of the underlying carbonate materials and the impervious clay beds that predominate in the area, such impacts will be localized. The potential impacts due to seepage and/or collapse will be determined in site specific studies.

Process modification dealing with the reduction of slime-pond area will have a significant localized effect on topography. When current slime ponds are reclaimed with conventional natural dewatering techniques, the result is a final topographic surface that is considerably different in both contour and elevation from that existing prior to mining; generally, the final surface is flat-lying and elevated over the original surface. Applying the sand/clay slime-mix technique to eliminate slime ponds will result in a final surface that closely approximates the original surface in both contour and elevation. However, because of the small area involved in slime ponds relative to the total study area, the impact on the topographical relief is not highly significant over the entire study area. Locally, impacts of such a change in clay-slime disposal methods would be significant.

Reducing slime-pond extent will have a positive effect on the area's unique physical features because of the significantly reduced potential for collapse of karst features, although (according to Kaufmann and Bliss 1977), sinkhole (karst) collapse and similar acute incidents are uncommon or at least not well documented in regulatory-agency files.

b. Biological Environment

Mining has five major effects on uplands/wetlands biota:

- Certain existing plant communities are permanently displaced.
- As much as 30 percent of mined uplands/wetlands habitat becomes aquatic habitat.
- Habitat quality of unmined as well as mined land is degraded.
- Diversity is diminished.
- Local populations of many important species are reduced.

By the year 2000, approximately 21,052 hectares (52,000 acres) of uplands habitat will be mined in currently permitted areas. In the 7-county area, forest types are considered the most important uplands habitat. Estimates of evergreen forests are considered reliable, but it is impossible to estimate present or future areawide extents of either mixed or deciduous forests because of the paucity of data of appropriate detail. Some rather large parcels in projected mining areas are documented in land-use data presented by various phosphate companies in Developments of Regional Impact (DRIs) - and they probably are present in areas currently being mined. None of the forest types can be restored to their native condition on mined land. The deep sand soils necessary for mixed forests are irreversibly altered; the loss of an underlying organic hardpan precludes the reestablishment of typical pine flatwoods; and the configuration as well as the species composition of hammocks is destroyed, although postmining soils, if allowed to revegetate naturally, will support similar communities. The 4850 hectares (12,000 acres) of forest to be mined by the year 2000 represents more than one-half the areawide loss of the type by that year.

Less important but still unreclaimable in its native condition is mined rangeland, the extent of which is 6680 hectares (16,500 acres) in the study area. The 8660 hectares (21,400 acres) of agricultural areas to be mined can be considered temporary displacement, since reclamation is producing improved pasture primarily with smaller extents of plantations and parklands.

More than 2990 hectares (7400 acres) of freshwater wetlands habitat within currently permitted mining areas will be destroyed by 1985 and another approximately 2140 hectares (5300 acres) by the year 2000. This is a small (3 percent) but important portion of areawide wetlands extent. There is no indication that wetlands of any kind can be restored on mined land. Not only are the low-relief topography and attendant drainage patterns of wetlands difficult to restore, but the deep, water-logged soils of many wetlands can be neither restructured nor feasibly conserved.

That the quality of terrestrial habitat generally reclaimed in mined areas is inferior is readily apparent when comparing wildlife usage of managed systems (pasture, cropland, plantation, and parkland) with that of essentially natural systems (dry prairie, forest). Mining and subsequent reclamation are producing a more uniform habitat, reducing diversity of community structure in the region. The number of plants and animals in an area is directly related to the number of vegetation types (landscape-pattern diversity): as landscape-pattern diversity increases, so does floral and faunal diversity. The habitat types that are declining in the regional landscape are those of greatest variety of interactions among components (expanded food webs) and biological controls that tend to preserve an equilibrium. They can be maintained at no cost to man. To maintain agricultural habitat types as such (and particularly monocultures, which are the least diverse communities), it is necessary to use external controls such as pesticides, fertilizers, and, most pertinent to the concerns of the region, irrigation.

The same factors that affect the habitat quality of uplands also affect the habitat quality of adjacent and nearby wetlands that are not mined. Both plants and animals may be stressed by noise, dust, emissions (sulfur dioxide, suspended particulates), moisture loss, and erosion - and animals particularly may be stressed by fragmentation of habitat. Although control devices apparently maintain ambient levels of emissions and minor contaminants within acceptable state and federal air quality levels, the emissions standards and other standards do not enhance habitat quality or ensure optimum conditions; habitat is allowed to degrade to the tolerance limits of both industry and the environment. Habitat fragmentation will have lasting effects,

likely reducing the carrying capacity of the remaining habitat for wide-ranging herbivores (e.g., deer) and carnivores (e.g., bobcat).

The effects of erosion and moisture loss may be greater in shallow wetlands than in uplands habitat. Mining into the shallow aquifer decreases the amount of soil mositure or standing water in adjacent habitat within 1000 feet for 3 to 6 months, and wetlands vegetation damage is possible, particularly during the wet season. Although erosion of mined land may be largely contained on the site, sediment load in streams increases and downstream wetlands receive part of the load, increasing turbidity and sedimentation.

Mining is likely to affect 12 threatened and endangered vertebrates and may affect six others (see Table 3.1). Adverse effects, if any, on two species, the Osprey and Caracara, likely will be short term, and the Osprey particularly may benefit in the long term. Two species, the Least Tern and Peregrine Falcon, both primarily coastal species, may be attracted to the mining areas; however, this is an outside possibility for the very rare falcon, which was last seen in the study area 3 years ago. Habitat loss is the primary threat posed by mining except in the case of the Wood Stork; this species utilizes suitable feeding sites on land to be mined but apparently does not breed on this land. Food supply of the Florida panther and Florida black bear also will be diminished, if indeed they do range over lands to be mined.

Commercial and recreational species will be variously affected by mining. The hunting potential for most waterfowl will increase because of the creation of lake and pond habitat by mining (Table 3.2), but that of the other waterfowl species closely associated with woodlands and marshes will diminish. However, waterfowl comprise less than 10 percent of Florida's game bag; hunter effort is directed primarily (approximately 75 percent) toward only five species - deer, squirrel, dove, quail, and wild hog. The recreational potential of hunting quail and squirrel, which often occur on lands other than in management areas, will be reduced. Deer and wild hog habitat will be reduced, but the hunting potential probably will not be affected for these species since they are most often hunted in wildlife management areas. The potential for hunting the Mourning Dove (often on private land) is expected to remain steady. The

	Fauna	Major Threat	Habitat (primary and secondary if applicable)	Range in Florida
Most Likely To Be Adversely Affected	Florida Gopher Frog	Habitat loss	Sandhills Sand pine scrub (gopher tortoise dens)	Parts of panhandle and peninsula
	Gopher Tortoise	Habitat loss	Sandhills Pine flatwoods	Most of pandandle and peninsula
	Sand Skink	Habitat loss	Sand pine scrub Sandhills	Marion County south to Highlands County
	Eastern Indigo Snake	Habitat loss	Pine flatwoods Other forests and prairies (gopher tortoise dens)	Most of state
	Short-tailed Snake	Habitat loss	Sandhills Sand pine scrub, pine flatwoods	Peninsula north of DeSoto County
	Wood Stork	Food availability	Wetlands	Wide; colonies local
	Florida Scrub Jay	Habitat loss	Sandhills, sand pine scrub	Middle of peninsula
	Florida Sandhill Crane	Habitat loss	Prairies Old fields, low pastures, pine flatwoods	Most of peninsula; local in north Florida
	Bald Eagle	Habitat loss	Riparian	Wide
	Florida Mouse	Habitat loss	Sand pine scrub Other forests	Northern two-thirds of peninsula
	Sherman's Fox Squirrel	Habitat loss	Pine flatwoods Other forests	Northern two-thirds of peninsula
	Southeastern American Kestrel	Habitat loss	Pine flatwoods	Statewide except southern tip
May Be Adversely Affected	Blue-tailed Mole Skink	Apparently restricted to Lake Wales Ridge		
	Short-tailed Hawk	Presence in study area infrequent		
	Ivory-billed Woodpecker	Probably extinct		
	Florida Panther	Presence in mining areas doubtful		
	Florida Black Bear	Presence in mining areas doubtful		
	Red-cockaded Woodpecker	Nearest sightings somewhat east of mining areas in Polk, Hardee, and DeSoto counties; habitat restrictive		
Adverse Effects Marginal and Short-Term	Osprey	Presence in old mining areas frequent; will utilize modified habitats		
	Caracara	Presence in mining areas infrequent; will utilize modified habitats		

*Determined by USDI and FGFWFC.

Table 3.1. Threatened and Endangered Vertebrates That May Be Affected by Proposed Action

Common Name	Reclaimed Lakes	Shallow Ponds and Shallow Mining Pits	Other Water Bodies	Streams	Forested Wetlands	Non-forested Wetlands
Canada Goose	L*		L			
Mallard	L	M*	M	L	L	M
Black Duck	L	L	M	L	M	M
Mottled Duck	L	M	M	L	L	M*
Pintail	L	M	M	L	L	M
Gadwall	L	L	M	L	L	M
American Wigeon	L	L	M	L	L	M
Northern Shoveler	L		M			
Blue-winged Teal	L	M	M	L	L	M
Green-winged Teal	L	M	M	L	L	M
Wood Duck	L	L	M	M	M	M
Redhead	L		M			
Ring-necked Duck	M	M	M	L	L	L
Canvasback	L		L			
Lesser Scaup	M		M			
Bufflehead			L			
Ruddy Duck	M	L	M			
Hooded Merganser	L	M	M	L	M	M
Red-breasted Merganser			L			
American Coot	M	M	M	L	L	M

*L - light
M - moderate
H - heavy

Table 3.2. Commercial and Recreational Species That May Be Affected by Proposed Action

region's overall abundance of game will not be significantly affected, but continued habitat loss eventually will eliminate certain species from the game list and degrade the quality of hunting.

Mining will adversely affect more than one-half of approximately 75 ecologically significant species in the 7-county region. Most of these are closely associated with various natural or little-modified habitats, including wetlands and natural ponds and lakes that have gently sloped sides and wide littoral zones rather than the steep sides and narrow littoral zones of reclaimed lakes and ponds.

Mining activities will increase the potential of several species to reach population levels of nuisance or pest proportions. Mammal pests will proliferate around work areas and expanded urban areas. Bird pests will become more abundant in similar areas as well as on reclaimed pastures and croplands. Insect pests will proliferate around cattle, in areas devoted to monoculture, and in the nutrient-rich reclaimed lakes.

Process modifications included in the proposed action will not significantly change the impact on terrestrial biota from that resulting Scenario 2.11 described in Volume II of this FEIS. Minimizing rock-drying may eliminate or reduce possible fluoride uptake by nearby flora, particularly in the new mining area. Reducing fluoride emissions from gyp ponds may slow the rate of accumulation of fluoride in susceptible flora near the processing plants.

Since process modifications apply only to new sources, slime disposal and management at existing sources will continue to be a problem (though, if properly managed could become substitutes for category 2 wetlands) through the remainder of this century (Figure 3.2). Minimal impact has been assigned to slime placement, since the ponds temporarily support a variety of wildlife and since terrestrial habitat eventually will develop or be reclaimed in the slime areas. Even now, the time lag in developing terrestrial habitat can be reduced in some areas by using the flocculation method of dewatering - but whether this or the proposed sand-clay method is advantageous from the standpoint of terrestrial biota is questionable. Neither the present, fairly immediate use (within approximately 6 years after final deposition of slime) of the land for

light agriculture nor the more immediate availability (within 2 years after deposition) for similar purposes in the future is preferable from the standpoint of wildlife production and natural revegetation. Several abandoned slime areas are now used as wildlife sanctuaries. Also not necessarily advantageous is the elimination of the relief of slime-pond embankments; actually, vegetational zonation associated with the slopes is more desirable for terrestrial biota. Naturally revegetated slime areas that have been partially leveled and shaped are still more desirable than pasture reclamation as wildlife habitat.

Additional standing waterbodies created by reservoirs for storage of water recovered from slimes would displace terrestrial habitat. The effects on terrestrial biota would be similar to those associated with mining pits. Since there is no estimate of the areal extent of the necessary containments, quantitative impact cannot be judged; however, the extent is expected to be minimal compared with that of mining pits. Reduced usage of ground water (the result of using the water received from slimes) will have no effect on terrestrial biota. Any groundwater change that may affect terrestrial biota will occur during mining into the shallow aquifer.

The assessment associated with mining wetlands was determined, as with other habitat types, by considering the importance of the habitat and the feasibility of its restoration. The worst-case assessment is consistent with other findings, including an EPA-sponsored study (Darnell 1976), which concluded that loss of wetland habitat is the most important impact of construction activity.

Mining in wetlands, mixed forest, and deciduous forests, because of their importance to surrounding ecosystems and their uniqueness, is considered worst-cast. Approximately 6 percent (10,850 hectares, or 26,800 acres) of the present areawide wetlands extent will be mined by the year 2000. Although unrealistic projections of future areawide wetlands extent preclude estimating areawide change attributable to mining, there are indications that greatest depletion will occur in the mining area. The loss of only several hundred acres of mixed and deciduous forest types (sandhills, sand pine scrub, and hammocks)

will severely deplete the unknown but undoubtedly limited extent of these important habitats.

By 2000, mining will account for 62 percent of the projected 7 percent areawide loss of forest (primarily evergreen), 62 percent of the projected 4 percent areawide loss of rangeland, and 85 percent of the projected 7 percent loss of pasture and cropland. The severe impact of mining in pine flatwoods is tempered by the projected remaining areawide extent of the type, as well as by the fact that unmined, unmanaged rangelands possibly could succeed to pine forest. The level of impact associated with mining rangeland will depend on the amount of true dry prairie included - apparently, there is little. The impact of mining pasture and cropland is considered to be negligible. Of the 55,789 hectares (137,800 acres) of uplands/wetlands habitat to be mined by 2000, as much as 16,599 hectares (41,000 acres) will be permanently displaced by water. As wildlife habitat, waterbodies created during reclamation are, like terrestrial habitat, generally inferior to those that could develop naturally were the mining areas merely abandoned.

The impact of noise, dust, and gaseous and particulate emissions on the biota of the region is largely unquantifiable, as is the impact of surface- and groundwater changes and erosion. Of prime concern are the effects that the alteration of water regime and sedimentation will have on the remaining wetlands; these are not addressed to the extent of similar effects on waterbodies. Although most effects pertinent to habitat quality are claimed to be temporary and not of sufficient magnitude to prevent recovery, long-term effects (e.g., reduced carrying capacity) that preclude complete recovery are quite possible.

Since phosphate mining will account for most of the expected areawide change in land use by the year 2000, it will account also for most of the change in community structure. Particularly will the modified habitat types replacing forests and wetlands support a smaller variety of biota and be considerably less productive in terms of life support. Mining will expand within or into the five

counties that are already most highly modified by urbanization, industrialization, and agriculture (Polk, Manatee, Hillsborough, Hardee, and DeSoto). There will be an increase in the proportion of managed systems that require expenditure of energy to natural systems that do not. The regional carrying capacity, which is the ability of the regional environment to sustain particular levels of activity, may be stressed.

The greatest impact on threatened and endangered species that likely will be affected by mining will come primarily from loss of uplands forested habitat. Actual or potential impacts that are considered worst-case involve the Florida mouse, short-tailed snake, sand skink, and Florida Scrub Jay because of their endemic status, limited distribution in the study area and state, and restricted habitat (scrub). Impacts on the Florida gopher frog and Southeastern American Kestrel could be severe: the widespread but local kestrel could be eliminated from the region if major concentrations within or near the mining areas were substantially reduced. Six other species - the gopher tortoise, eastern indigo snake, Sherman's fox squirrel, Wood Stork, Florida Sandhill Crane, and Southern Bald Eagle - are expected to be moderately to substantially impacted. Mining will directly reduce populations of some of these species and, coupled with reclamation, will limit opportunities for all of them. They generally are widespread in the study area and equally or more abundant in areas not affected by mining.

Loss of forests (and in this case, particularly wetlands) will have the greatest impact on ecologically significant species. Some of the water-oriented species may utilize shallow mining pits and vegetated slime ponds, but these habitats are displaced during reclamation. Permanent population declines are expected among most of the affected species.

The impact on the hunting and trapping potential of commercial and recreational species is considered minimal, as is the impact of increased abundances of nuisance and pest species. There is intense management in both of these categories, and increased costs of management undoubtedly will accompany changes in land use. The impacts could be greater than minimal, but a more accurate assessment is difficult without cost estimates.

In view of the fact that freshwater wetlands restoration has not been demonstrated and seems infeasible on a large scale within a reasonable time, the only practical approach to analyzing impacts of this part of the proposed action is to assume prohibition of mining or development of facilities in waters of the U.S. and wetlands. In order to apply importance criteria for regulatory purposes, wetlands must first be differentiated from other waterbodies and from each other as well. Water relationships, vegetation, and soil types are among the factors that would be included in wetlands definitions. In general, a water regime that includes alternating inundation and water release of various periodicities hydrologically distinguishes wetlands from waterbodies, although shallow submerged lands often are included as wetlands. As indicated previously, the national wetlands delineations and inventory currently underway withing the U.S. Fish and Wildlife Service should be helpful in determining wetlands types and areal extent. It is anticipated that the wetlands inventory within the study area will be completed by early 1979.

Designating wetlands as protected areas would eliminate the worst-case impact associated with mining them and would lessen impacts on important species. If wetlands are allowed to be mined on the uncertain basis of restoring equivalent habitat for important species, the impact assessment for terrestrial biota remains the same as described for Scenario 2.11 in Volume II of this FEIS.

Determination of wetlands to be protected and wetlands to be restored to perform useful functions will of necessity be made on a site specific basis.

3. Water

a. Quantity

A digital computer model (Wilson 1977) that was prepared, evaluated, and calibrated by personnel of the U.S. Geological Survey office in Tampa in cooperation with the Southwest Florida Water Management District was used in assessing the effects on the Floridan aquifer of phosphate industry activities.

The model is a first attempt to simulate the complexity of the interrelationships of all the essential elements of the ground-water system in the Central Florida Phosphate Mining District. Therefore, the results should be considered as preliminary and subject to revision. The USGS is continuing the task of improving the reliability of the model. These first model predictions are represented as approximate and are used only to estimate the effects of future groundwater pumpage by the phosphate mining industry on the potentiometric surface of the Floridan aquifer. Effects of the changes in total pumpage by the three major users of ground water (i.e., municipalities, agriculture, and other industry) are not predicted. Therefore, the partial effects on the potentiometric surface of the Floridan aquifer in 1985 and 2000 caused by changes in pumpage at phosphate mines exclusively cannot be compared with the effects of combined groundwater withdrawal changes by municipalities, agriculture, and other industry. This inability to compare effects is a distinct disadvantage in the effects assessment.

The digital 2-dimensional groundwater flow model simulates the hydraulic characteristics of the Floridan aquifer and its connection with the water-table aquifer through the overlying confining beds. (More detailed information is available in the USGS open-file report [Wilson 1977] from which this description is summarized.) The major assumptions upon which the design and operation of the model are based are as follows:

- Water in the Floridan aquifer moves in a single-layer isotropic medium.
- Water moves vertically into or out of the Floridan aquifer through the upper confining beds; no leakage occurs through the lower confining bed.
- The head in the water-table aquifer does not change with time or in response to any imposed stress.

The area within the model boundaries is approximately 5854 square miles. A grid divides the area into nodal blocks ranging from 2 x 2 miles to 8 x 2 miles and 6 x 6 miles. Each nodal area is identified by a row and column types: a constant-flow boundary and a constant-hear boundary. For the steady-state model calibration, a no-flow boundary was used.

The model incorporates two types of parameters: time-dependent and time-independent. The input and output parameters, which include pumpage (P) and/or recharge (R) and predicted changes in the potentiometric surfaces, are time-dependent. The other parameters, which include transmissivity (T), storage coefficient (S), and leakance coefficient (K'/b'), are time-independent. The input parameter, or pumpage, consists of groundwater withdrawals for phosphate mining, chemical plants, other self-supplied industries, agriculture, and municipalities. The input parameter, or recharge, is the amount of water that enters the Floridan aquifer from the overlying water-table aquifer. The amount of recharge depends on the leakance and the head difference (Δh) between the potentiometric surface and the water table.

The model can simulate either dynamic (transient) conditions or steady-state conditions in the hydrologic system. Under steady-state conditions, the model simulates essentially a static water budget; in the transient state, it simulates a dynamic water budget.

The present model was calibrated under steady-state conditions. The entire groundwater system was assumed to be more or less in equilibrium (steady-state) at the end of September and the beginning of October 1975; at that time, there was apparent balance between pumpage, recharge, and observed altitudes of the potentiometric surface of the Floridan aquifer. It was assumed for the steady-state condition that in the September-October period no ground water was pumped for agricultural use.

The objective of the model calibration was to simulate as closely as possible the observed potentiometric surface in September 1975. During the calibration of the model, several adjustments were made in the various parameters.

Comparison of the observed and simulated potentiometric surfaces showed a similar pattern generally in the configuration of the potentiometric surfaces, but locally there were some major differences between the two. For example, the simulated altitudes of the potentiometric surface in the western half of Manatee and northern Sarasota counties were significantly lower than the observed altitudes in the same area. This was true also for the southwestern part of Polk County. The steady-state model appeared to overestimate

the drawdowns in these areas, which could have been the result of the following factors: actual pumpage less than that entered in the model; leakance coefficients less than actual ones; transmissivity values less than actual ones; and possible proximity to the model boundaries. Magnitude and configuration of predicted water-level changes depend on the magnitude, duration, and areal distribution of pumpage, transmissivity, storage coefficient, leakance coefficient, and boundary conditions. The reliability of the predicted water-level changes is only as accurate as the validity of the least reliable parameter. The calibration process is, in a way, a reliability assessment.

Evaluation of results was difficult because only the calibration results of the steady-state model and not the transient-state model were available. However, the predicted water-level changes were a result of transient-state model simulations.

The validity of each parameter was evaluated. The areal distribution and magnitude of the model parameters appeared to be not much different from those that might have been expected in reality, although some values of the leakance coefficient appeared to be on the low side. The magnitude and areal distribution of the transmissivity values were of major concern, especially the value of 80,000 square feet per day in the southwestern part of the study area. In reality, it seems reasonable to expect that the transmissivity should increase from north to south and from east to west. The author of the referenced report on modeling (Wilson 1977) was contacted and indicated that the transmissivity distribution produced a fair match during the calibration process. In addition, he considered and tried other transmissivity values more along the lines suggested above but did not get a good match. The USGS is continuing to work on the calibration and will try other transmissivity values and distributions.

In summary before citing the primary effects, it can be said that the assessment is really one of trends in the water-level changes in 1985 and 2000 for "without action" and Scenario 2.11 alternatives. The numbers quoted are relative approximations and should not be interpreted as absolute results.

The primary effects of groundwater withdrawals as described in Scenario 2.15 are expressed as a change in the potentiometric surface of the Floridan aquifer between September 1975 and September 1985 and between September 1975 and September 2000. Total pumpage for existing mines and chemical plants was 309,000,000 gallons per day in 1975 and is projected to be 142,000,000 gallons per day in 1985, representing a decline of more than 50 percent. Groundwater pumpage for existing mines is expected to decline to 6,000,000 gallons per day in the year 2000, with chemical-plant pumpage remaining constant throughout the period. It was assumed in examining the effects of the "without action" alternative that pumpage by agriculture and municipalities will be at the same level in 1985 and in 2000 as it was in 1975. The actual water-level changes can be quite different if the projected increase or decrease in agricultural and municipal pumpage is simulated in the model runs.

According to model results, the potentiometric surface of the Floridan aquifer will generally recover in 1985. The greatest rise (approximately 10 feet) will be in Polk County just west of Fort Meade. The 5-foot contour line indicates a recovery over a larger area between Bartow, Mulberry, Agricola, and Bowling Green. The 1-foot rise in the potentiometric surface will be in the southwestern part of Polk County, extending south of Lakeland, southwest of Winter Haven, north of Wauchula, east of Keys Field, and west of Bradley Junction. The no-change line runs approximately in a north-south direction, just east of the Hardee-Manatee county line and then swings northwesterly into Hillsborough County. The only decline predicted by the model was a 1-foot decline in the Fort Lonesome area. In general, the model showed no changes in the potentiometric surface of the Floridan aquifer in the study area except in southwestern Polk County and southeastern Hillsborough County.

By the year 2000, nearly the whole study area will experience a rise in the potentiometric surface. The greatest rise, about 30 feet between 1975 and 2000, will be centered in an area northwest of Fort Meade in southwestern Polk County, extending southwesterly into Manatee and Sarasota counties. The model predicted a 1-foot rise in the potentiometric surface southwesterly as far as the center of Sarasota County in the Lake Myakka area and also in the western part of Manatee County.

To simulate "worst-case," the "industry view" was used in the USGS model; thus an extension across more mines than under the proposed action. The model predicted water-level changes in 1985 and 2000 with respect to the September 1975 potentiometric surface of the Floridan aquifer. These water-level changes will also affect the hydrologic system by increasing induced recharge from the water table to the Floridan aquifer, for example, and possibly causing subsequent reductions in streamflow. There will also be an economic effect: a rise in level will reduce pumping costs; a decline will increase pumping costs. A change in the potentiometric surface in the coastal zone might also affect the movement of the saltwater/freshwater interface in that area.

The water-level change for 1985 indicates an approximate 1-foot rise in the potentiometric surface in the Bartow area and a decline of about 10 feet in the Four Corners area. This pattern of decline is quite likely, since phosphate mining activities are expected to shift from southwestern Polk County in a south-southwesterly direction toward Manatee and Hardee counties. Not only will there be a 10-foot decline in the Four Courners area but also in small areas near Myakka Head, Bowling Green, and Ona. A 5-foot decline will extend from southeastern Hillsborough County through the middle and western parts of Manatee County into and across the middle of Hardee County and the southern half of Polk County. A 1-foot decline will parallel most of the coast in Hillsborough, Manatee, and Sarasota counties, extending as far south as Port Charlotte. Thus, the effect of proposed and existing phosphate mining generally will be over the whole Central Florida Phosphate District, a decline ranging from 1 and 10 feet compared with the September 1974 potentiometric surface level.

The water-level change for the year 2000 indicates an approximate 20-foot rise in the potentiometric surface in southwestern Polk County relative to the September 1975 levels. This rise will occur in an area south of Bartow. The rise is explained by the fact that a large number of present phosphate mines in the area will be phased out by the year 2000 and that the major mining will shift in a southerly and southwesterly direction into western Manatee County, middle and southern Hardee County, and northern DeSoto County. This movement will be reflected by a decline of approximately 10 feet in western Manatee County and eastern Hardee County. Additionally, two small 10-foot declines are predicted near Ona and Sandy. Comparing 1985 and 2000, it is interesting that

the predicted 1-foot decline in the potentiometric surface is still at the same location (i.e., along the coast in Hillsborough, Manatee, and Sarasota counties) despite the increase of phosphate mining.

Again, it should be emphasized that the water-level changes reflect only the changes in activities of the phosphate industry. The results might be quite different if pumpage changes caused by municipalities and agriculture were entered into the model.

In summary, it appears that the worst-case effect under Scenario 2.11 would be a drawdown of approximately 10 feet (relative to 1975 levels) in western Manatee County by the year 2000.

b. Quality

1) Radiological

Kaufmann and Bliss (1977) summarized the radium-226 radioactivity concentrations in the waters of the water-table and the upper and lower Floridan aquifers in the mined regions of central Florida (Table 3.3) using two data sets - one developed by the USEPA and the other by the USGS. The mean concentration of radium-226 radioactivity in the water-table waters of mined areas was given as 0.55 picocuries per liter; for the upper Floridan, 1.61 picocuries per liter; and for the lower Floridan, 1.86 picocuries per liter. The authors state that lower Floridan waters outside the mineralized area can have higher concentrations than those in mineralized areas, apparently because of natural processes unrelated to mining, and that existing water-table radium data indicate no significant difference between mined and unmined regions within the area of mineralization. However, ground water has been and probably will continue to be locally contaminated. Specific areas of concern include the large slime impoundments, the waste-gypsum stacks, and the large process-water cooling ponds. For comparison, Table 3.4 presents radium-226 radioactivity concentrations in ground waters of central Florida's mineralized but mined areas and nonmineralized areas.

Table 3.3. Radium-226 Concentrations in Ground Water in Mined Regions of Central Florida*

Aquifer		Picocuries per Liter EPA		USGS	
Water Table	No.	4		12	
	Mean	2.8		0.55	**
	SD	1.65		3.3	
	Range	2.0-5.3		0.20-4.40	
Upper Floridan	No.	No data		10	
	Mean			1.61	**
	SD			2.0	
	Range			0.16-6.0	
Lower Floridan	No.	6		7	
	Mean	1.86	**	4.49	
	SD	1.33		6.51	
	Range	1.3-3.5		0.14-14.0	

*Kaufmann and Bliss (1977)
**Author-preferred data
Note: Drinking water standard, 5 picocuries per liter combined radium-226 and radium-228.

Industry wastewater effluents at the chemical processing plants contain soluble radium-226, but, according to Mills et al (1977):

> "To prepare process water for discharge to the environment, the pH must be increased from 1.5-2.0 to 6-9. To accomplish this, slaked lime is normally added to the discharge water in a step called 'double liming.' Our studies have shown that this treatment is highly effective in removing radionuclides from the effluent. Radium-226 reduction of greater than 96 percent was observed in all situations studied. Similar reductions in uranium and thorium were also observed."

Table 3.4. Radium-226 in Ground Water in Unmined Mineralized and Nonmineralized Regions of Central Florida*

Region	Aquifer		Picocuries per Liter	
			EPA	USGS
Mineralized, Unmined	Water Table	No.	3	23
		Mean	1.63	0.17
		SD	1.65	12.9
		Range	0.2-3.3	0.05 - 22.0
	Upper Floridan	No.	9	5
		Mean	3.06	2.30
		SD	3.35	3.35
		Range	0.18 - 10.6	0.24 - 7.70
	Lower Floridan	No.	24	9
		Mean	2.0	1.4
		SD	2.3	1.3
		Range	0.19 - 15.3	0.06 - 4.7
Nonmineralized	Water Table	No.	No data	No data
		Mean		
		SD		
		Range		
	Upper Floridan	No.	No data	3
		Mean		5.1
		SD		4.3
		Range		0.2 - 7.9
	Lower Floridan	No.	14	2
		Mean	1.4	2.8
		SD	2.5	1.4
		Range	0.23 - 14.7	1.8 - 3.8

*Kaufmann and Bliss (1977).
**Author preferred data.

Note: Drinking water standard, 5 picocuries per liter of combined radium-226 and radium-228.

In terms of radium-226 radioactivity concentrations, effluents (primarily slime decant waters) at the mines have been shown to be below drinking-water standards (in most cases less than 2 picocuries per liter). The interim effluent guide proposed by the EPA (USEPA 1974) for the phosphate industry (phosphate chemical and fertilizer manufacturing) in terms of radium-226 is 9 picocuries per liter. However, efforts to achieve total recirculation of plant and mine waters are ongoing within the phosphate industry.

2) Other Parameters

The primary effects on water quality because of phosphate industry activities under this scenario are:

- Combined loadings of chemical pollutional parameters (especially phosphates, fluorides, and total suspended solids) from discharges of nonprocess and process wastewaters to various stream segments
- Local surface-water deterioration from clearing, burning, construction, reclamation, slime spills, and seepage from contaminated ponds
- Local water-table quality deterioration because of draining and dewatering, overburden, product storage, seepage from contaminated ponds, and reclamation of mining pits

Effects on water quality under the conditions of this scenario will be significantly different from those under the "Without Action" alternative in terms of the technological demand elements of slime placement, processing-water use/recycle in regard to fluoride effluents, and processing-waste placement in regard to radiation from gyp stacks.

Reducing slime-pond areas above surface would minimize the additional concern under Scenario 2.11 in regard to slime-pond dike breaks. In relation to the "Without Action" alternative, then, the effect of this modification in regard to surface-water pollution would be negligible.

Following the water quality versus streamflow trends discussed earlier, the loss of slime-pond decant water to the average streamflow will tend to lower the quality of water in affected streams during periods of low flow, but the influence of the proposed action should have little effect on water quality during periods of high runoff due to rainfall.

No projections are made on water quality effects for New Source Chemical Plants, because none are expected in the proposed action. However, in the event development does not follow projections, and application is made for a New Source Chemical Plant, the proposed action requires more stringent limitations than EPA New Source Performance Standards to protect water quality in the affected basins.

c. Aquatic Biota

1) Areas Affected by Phosphate Industry Activities

Over the short term (1977-85), phosphate mining is expected to occur principally in southwestern Polk County and southeastern Hillsborough County. Aquatic habitat likely to be affected includes the upper portion of the Peace River; the upper reaches of Payne and Little Payne creeks; Horse Creek; McCollough Creek; and the north and south prongs of the Alafia River. Riparian wetlands along portions of the Peace River and the north and south prongs of the Alafia also are expected to be disturbed, as are numerous small standing water-bodies and wet depressions characteristic of the region. Over the long term (1985-2000), mining activities will be essentially limited to the same general areas described for short-term activities and will continue to affect the water-bodies disucssed. Additionally, mining activities will expand into the upper portion of the Little Manatee River basin and farther down the Peace River in the vicinity of Bowlegs Creek.

Reducing wetland disturbance will result in a net positive benefit to local aquatic biota. The habitat disturbance and displacement of the American alligator will be reduced, as will disturbances of communities of standing water and running water often associated with wetlands.

2) Threatened and Endangered Species

Of the 13 aquatic species endangered, threatened, rare, or of special concern, only the American alligator (threatened; USDI), Suwanee cooter (threatened; FGFWFC, FCREPA), and manatee (endangered; USDI) might potentially be affected by phosphate industry activities in the study area. Land preparation and mining (particularly in the riparian wetlands bordering the Peace River and the north and south prongs of the Alafia River) will cause some loss of habitat and displace the American alligator but likely will have no adverse impact on the area's alligator population. These local disturbances could be offset by reclamation of gently sloped, shallow waterbodies that would be appropriate habitat for the alligator. Over the long term, mining's alteration of surface runoff patterns and creation of numerous impoundments during reclamation will alter the Peace and Alafia flow regimes, but the alterations will be of small magnitude and are expected to have only very minor effects on the Suwanee cooter and manatee through a potentially altered distribution of food plants.

Slime placement poses a potential for the most significant adverse impact on rare and endangered aquatic species of the study area. Because of the long time interval required for reclaiming slime ponds, increasing mining activity represents increasing potential for adverse impact through spills resulting from dam failure and human error. A major spill would have substantial adverse effects on the American alligator, the Suwanee cooter (Alafia River only), and the manatee by disrupting the food chain. Although the immediate effects of such a spill are severe, the impact is reversible because stream ecosystems generally recover in 2 to 5 years (based on the spill's magnitude).

3) Species of Commercial and/or Recreational Importance

Direct effects will be limited principally to freshwater communities. Freshwater species of recreational and/or commercial value within the study area include largemouth bass, channel catfish, bream (bluegill and other sunfishes), and blue tilapia. Short-term effects generally will be local and the result of land preparation and excavation, which alter habitat quality by changing local

runoff patterns and increasing turbidity and siltation due to erosion. However, the areas affected would be small and only lightly utilized for recreational or commercial purposes.

A significant potential beneficial effect on freshwater sport and commercial fisheries will be the increased acreages of surface water resulting from reclamation of mining pits. This additional surface water represents significant potential for establishing good commercial and recreational fisheries. If this potential is to be fulfilled, however, present reclamation must be latered to include lakes and ponds with wide littoral zones and other areas (e.g., "marshy" islands) that would increase habitat diversity and support a viable sport fishery. The steep-sides, relatively deep lakes now predominating are of little long-term value; they quickly become degraded and/or eutrophic.

Placement and containment of large amounts of slime resulting from mining activities is a growing threat to recreational and commercial species of the study area. A major spill could devastate a river-based fishery for several years and, depending on location and magnitude, have significant adverse impact on estuarine fish and shellfish of recreational and commercial importance. Also, the economically important estuarine fisheries are susceptible to the long-term effects of flow-regime modification through alteration of drainage patterns and creation of impoundments.

4) Nuisance and Pest Species

Categories of aquatic nuisance and pest species that are expected to be affected by phosphate industry activities in the study area include exotic hydrophytes (hydrilla, water hyacinth, etc.), algae (principally filamentous green and bluegreen forms), midges and mosquitos, Asiatic clams, native nuisance fishes (bowfin, gar, gizzard shad, etc.), and exotic fishes (walking catfish, blue tilapia). Draining and dewatering low, wet areas, thus eliminating breeding areas for midges and mosquitos, will have a positive effect but will be more than offset by the industry's creation of additional surface water.

5) Standing-Water Communities

The standing-water, or "lentic," aquatic communities of the study area comprise natural and man-made lakes and impoundments, ponds, pits, and seasonally wet depressions. Except for some interconnection of lowland wet areas, the standing-water communities represent rather discrete ecosystems. Thus, the effects of phosphate industry activities on standing-water communities, unlike those on flowing-water communities, are highly localized.

The amount of standing-water communities expected to be directly affected under the proposed action is relatively small and involves no major lakes, ponds, or impoundments. The samll ones will be affected principally through alteration of runoff patterns and increased siltation of cleared areas because of erosion. Also, there may be direct disruption due to land preparation and excavation. Perhaps the most important consideration will be the creation of new standing-water habitat. It has been projected that approximately 7280 hectares (18,000 acres) of mined land will be reclaimed to lakes between 1977 and 1985; by the year 2000, this area will be approximately 11,490 hectares (28,400 acres). This area, if properly reclaimed and managed, represents a considerable increase in resource potential for freshwater sport and commercial fishing.

6) Running-Water Communities

Of the three basic aquatic community types described for the study area, the running-water communities (streams and rivers) will experience the greatest effects from phosphate industry activities. Under the Proposed Action, approximately 14,130 hectares (34,900 acres) of land will be mined by 1985 in the upper Peace River Basin, approximately 120 hectares (300 acres) in the Little Manatee River Basin, and 5830 hectares (14,440 acres) in the Alafia River Basin. By 2000, disturbed surface acreage will increase to approximately 31,000 hectares (76,600 acres): i.e., 19,500 hectares (48,300 acres), 1417 hectares (3500 acres), and 10,000 hectares (24,800 acres), respectively. This

magnitude of activity will measurably affect runoff patterns and flow regimes of headwater streams within the three river basins and, to a lesser degree, flow regimes of the Peace, Alafia, and Little Manatee rivers. Local alterations of the flow regimes of these three major rivers will be minor and obscured in normal flow variations.

Another important factor affecting the flow regimes of streams in the study area will be the creation of large acreages of impoundments that cause loss of runoff water to the streams and a net loss of surface water from the area through evaporation. It has been projected that discharge decreases attributable to evaporation losses of impounded water in the Peace River Basin will be equivalent to about 15 cubic feet per second by 1985 and 21 cubic feet per second by the year 2000 in the Peace River, 6 cubic feet per second by 1985 and 1.5 cubic feet per second by 2000 in the Little Manatee. Average flows near the mouths of the three rivers are 1195, 175, and 373 cubic feet per second, respectively.

The total effect of phosphate industry alteration of the flow regimes of streams in the study area through 1985 will be minor. By 2000, however, the magnitude of alteration will be sufficient to cause some noticeable community shifts from organisms preferring flowing water to those more indicative of lentic, or standing-water, habitats; this will represent an adverse effect, since flowing-water communities are of greater resource value to the study area.

In addition to affecting the flow regimes of local streams, the industry's construction, land preparation, and excavation will cause some local degradation of stream habitat quality by increasing siltation and turbidity. However, such adverse effects are expected to be local, rather short-term, and only minor from a regional perspective. Community-structure alterations accompanying local habitat degradation by siltaiton and turbidity will be manifested as reduced algal abundance (benthic and periphyton communities), replacement of more desirable benthic forms (e.g., mussels, odonate, and mayfly naiads) with forms more tolerant of silty substrate (tubificid worms, diptera larvae), poorer condition of local fish populations because of food-chain disruption and impairment of feeding activities, and reduced fish egg and larva survival.

7) Bay and Estuarine Communities

Effects will be limited principally to mining's long-term effect on freshwater discharge patterns of the Peace and Alafia rivers (discussed in the preceding). Changes in freshwater discharge will alter salinity regimes within the river estuaries and thus affect distributions of estuarine organisms. However, the effects of the relatively small changes of freshwater discharge patterns are expected to be minor and obscured in normal discharge variations.

C. MAN-MADE ENVIRONMENT

1. Land Use

Assessing the impacts of mining on the environmental elements (in this case, land tenure, community/regional plans, and land use) is largely judgmental but is in the same direction (positive or negative) in almost every case as the effects listed for the "Without Action" alternative. Impacts on land uses are measured both by areal displacement by mining and overall effects on the total land system by displacement and subsequent reclamation.

Forests, agriculture, and open space will be areally displaced, resulting in negative impacts. These land uses are as important from the standpoint of wildlife and general habitat as for the economic value of their potential products (timber, cattle, etc.). Therefore the impact of their removal has been based on the loss of their economic as well as ecological values. Current reclamation practices have a negative impact on forests and open space, since these are not usually replaced; reclaimed land is most commonly used for improved pasture. This reclamation pattern will have a positive (economic) impact on agricultural land.

Increased mining under this scenario will stimulate economic growth, which will probably result in areal expansion of residential, commercial, and industryal lands. Residential is probably the land use most sensitive to any pollution, noise, or aesthetic degradation created should mining be located in close proximity. If mining occurs within several miles of residences, negative impacts are likely.

The "Permit Existing and New Sources" alternative will result in an increase of the area within the land use "Mining." Compared with the "Without Action" alternative, the conditions of the scenario include a projected 39 percent increase by 1985 and a 60 percent increase by 2000.

A letter from the Florida Department of Transportation (March 24, 1974) included in the referenced environmental impact statement points out that "...with larger vessels utilizing the harbor facilities, there could be a significant increase in both truck and rail traffic, as well as additional auto traffic generated by the enlarged labor force." The letter also points out the existing condition of "the situation of long freight trains bringing phosphate to Port Sutton, delaying traffic on SR 45 (US 41). This expansion can only augment the present problem."

Phosphate mining's major impact on land use in the study area is the displacement of acres in the various land-use categories. Forest land, agricultural land (USGS Level-II categories "Cropland-Pasture and "Orchards-Groves"), and open space (USGS Level-II categories "Rangeland" and "Transitional Areas") will be displaced (Table 3.5), while other land uses (residential, commercial, and industrial) will be affected areally through the economic stimulation of mining activities but will not be displaced because of their relative economic values. As an example, residential land may expand in certain areas (other than immediate mining areas) over time because of the influx of population stimulated by the presence of phosphate mining and related activities.

Table 3.5. Displacement Areas, 1985 and 2000 of Without Action Alternative

Land Use Categories (keyed to matrix elements)	Areas (hectares/acres)				
	(a) Four River Basins, Unadjusted	(b) Adjusted	(c) 1975 Unadjusted	(d) Area Mined According to Map	(e) Difference (c-b)
Forests	55,116/136,138	56,590/139,778	69,676/172,101	3,057/7,552	13,086/32,323
Agriculture	471,763/1,052,246	430,800/1,064,076	456,908/1,128,563	3,939/9,729	26,108/64,487
Open space (includes USGS categories rangeland and other barren land	471,763/1,165,255	483,949/1,195,355	492,648/1,216,843	3,834/9,472	8,699/21,488
Forests	58,807/145,255	60,281/148,895	69,676/172,101	4,845/11,968	9,395/23,206
Agriculture	426,947/1,054,560	431,736/1,066,390	456,908/1,128,563	9,561/23,616	25,171/62,173
Open space (includes USGS categories rangeland and other barren land)	469,539/1,159,763	481,717/1,189,843	492,648/1,216,843	6,685/16,512	10,931/27,000

Compatibility of the various land uses with phosphate mining varies. Residential land is the least compatible of all categories; on the other hand, forests and open spaces provide excellent buffer zones between mining and less compatible land uses. There will be more disturbed acres of forest, agriculture, and open space by the year 2000 than by 1985. By 2000, reclamation will have increased acreages in each of the mentioned categories over 1985 acreages but will not have restored them to their 1975 extents. Projections of the Four River Basins Area Economic Base Study summarized in Table 3.5 are not realistic since most reclaimed land probably will be returned as improved pasture and lakes. Planners (and land-use plans) in the study area, most of whom agree with the fundamental philosophy of the Four River Basins Study, may have unrealistic expectations for potential uses of reclaimed land. Placing additional constraints on the variety of future land use are existing laws and regulations specifying physical requirements for reclaimed land.

Mining will not adversely affect land tenure, either public or private, since mining companies already own almost all land that will be mined through the year 2000.

Elimination of slime ponds will not actually increase the amount of reclaimed land but will make land available for other uses more rapidly than at present. Since slime ponds occupy a major portion of areas that have been mined (TI 1977h), putting land into improved pasture sooner will have a negative impact on land-based recreation; slower revegetation provides habitat for hunted species.

Lining gyp ponds will reduce impact by minimizing the hazard of potential pollution of ground water. The potential hazard would be applicable to urban and agricultural land use (TI 1977e).

2. Archeological, Cultural, Historical, and Recreational Sites

Areas to be mined in the future (1976-2000) contain historical and archeological sites. The number of sites that will be disturbed is indicated in Table 3.6.

Table 3.6. Disturbed Archeological and Historical Sites*

Year	No. of Sites in Study Area	Scenarios 2.15	2.11	2.14
1985	791	6	11	1
2000	791	10	28	3

*Based on assumption of no additional sites discovered between 1976 and 2000.

Most archeological sites are considered by archeologists as fragile and, as such, would be permanently altered or destroyed if mined. Florida's Division of Archives, History, and Records Management (1976) has expressed concern that valuable sites within the study area may be lost or may suffer irreversible damage; this agency maintains that the effects will occur on a regional level and may result in the permanent loss of a sizable portion of Florida's archeological record. Unless measures to collect and preserve the artifacts are taken before mining, the state office's concerns will be valid.

More archeological and historical sites would be destroyed under the conditions of this scenario than under those of the "Without Action" scenario: five more sites would be destroyed by 1985; 18 more by the year 2000 (Table 3.6). The impact would be catastrophic, since irreplaceable historical resources would be lost.

Impacts of the proposed action in addition to those presented above are associated with controlling activities in wetlands. Thirty-nine archeological sites would be disturbed except by eliminating mining in wetlands; which would preserve 35 of them. This preservation mechanism only applies to known sites. Sites outside of wetlands may be discovered during site-specific investigations.

Recreation would be both positively and negatively impacted. The increased mining under this scenario would increase the possibility of accidental waste spills and resultant water pollution - and negative impact. Reclamation would increase hunting potential for most waterfowl - a positive impact. Loss of habitat associated with current reclamation practices would have a negative impact on the hunting potential of land-based game species.

As to existing and potential recreational areas, phosphate mining will have both positive and negative effects. Water-based recreation is particularly sensitive to wastewater spills. Such spills, especially the one on the Peace River in 1971, can be extremely destructive (Blakey 1973). Land-based hunting will be affected not only by habitat destruction due to mining but by the reclamation (e.g., to improved pasture) that does not restore habitat. Reclamation can provide additional recreational areas, however (e.g., Polk County's Saddle Creek Park), and should be planned with care to provide an aesthetic setting.

3. Demography, Economics, and Cultural Resources

The proposed action would impact the area's economics and the demographic and cultural elements. With respect to transportation, a special note is worthy of repeating as reported in the Final Environmental Impact Statement, Tampa Harbor Project (U.S. Army Corps of Engineers 1974):

> "From available data and coordination with the state geologist, it is estimated that there are from 26 to 30 billion tons of phosphate rock deposits in Florida, of which about 2.5 billion tons are considered marketable reserves using existing mining methods and present market and price conditions. About 1.5 billion tons of the marketable phosphate is in Polk County adjacent areas. This estimate is substantiated by the Florida Phosphate Council. Another billion tons of marketable phosphate is located in Hernando, Citrus, Marion, Levy, and Alachua counties, which, if developed, would require use of facilities at Tampa Harbor for shipment to areas of consumption. It is estimated that about 1.65 billion tons of phosphate would be shipped from Tampa Harbor during the 50-year life of the project - an average of about 33,000,000 tons per year. In addition, there would be production of phosphate for domestic consumption of about 7,000,000 tons per year which would not use facilities at Tampa Harbor."

One should be aware that all official population and economic projections that have been examined during the course of this study are based on the postulation of continued development of the phosphate industry in the study area.

The phosphate industry's existing ownership of large tracts of land on a north-south axis from Lakeland to Port Charlotte has probably been the major cause of the current crescent-shaped population concentration from Lakeland to Tampa and along the coast to Port Charlotte. Land use in the northern part of Polk County has been dramatically affected by the Disney World entertainment complex (just north of the Polk County line). Land values for residential and associated commercial development and tourist accomodations have increased at a tremendous rate in recent years, resulting in significant land-use changes. For example, land devoted to growing citrus has been removed from production and shifted to intensive development.

Table 3.7 shows the projected economic impact of the phosphate industry on the study area by scenario. The "Without Action" alternative would mean a loss of 2674 phosphate industry jobs in 1985 and 7554 by the year 2000. Phosphate industry payroll losses would be $20,700,000 in 1985 and $58,500,000 annually by the year 2000. One can see that losses in employment and payroll by phosphate industry-induced industry and business would be much greater. Since the service businesses catering to the needs of the retirement and tourist sectors are in direct conflict with the phosphate industry, however, there is good reason to believe that they could absorb surplus workers from the phosphate industry.

The study area is served by all modes of transportation. Trackage at Tampa Harbor connects to the Seaboard Coastline Railroad System. Two interstate highways, I-75 and I-4, along with other federal and state roads, connect the study area with other parts of Florida and the United States. Interstate 75 is scheduled to be constructed south along the Gulf Coast through the study area to the Florida east coast. Tampa International Airport, which is served by 10 major airlines, provides domestic and foreign service. Numerous shipping lines and barge lines have facilities in Tampa Harbor and provide extensive service to

Table 3.7. Projected Economic Impact of Central Florida Phosphate Industry from Domestic Mining Only on Study Area by Scenario, 1980-2000

Year	Scenario	Production (million short tons)	Phosphate Industry Employment*	Phosphate Industry Payroll** (000,000)	Induced Employment***	Induced Payroll**** (000,000)
1975	Actual†	38.2	8,512	65.8	52,349	221.3
1980	2.11‡	41.2	9,181	71.0	56,463	238.7
	2.15‡	42.2	9,403	72.7	57,828	244.4
1985	2.11‡	45.2	10,072	77.9	61,943	261.9
	2.15‡	33.2	7,398	57.2	45,498	192.4
1990	2.11‡	44.8	9,983	77.2	61,395	259.6
	2.15‡	27.5	6,128	47.4	37,687	159.3
1995	2.11‡	42.0	9,359	72.4	57,558	243.4
	2.15‡	9.1	2,028	15.7	12,472	52.7
2000	2.11‡	36.5	8,133	62.9	50,017	211.5
	2.15‡	2.6	579	4.4	3,560	15.0

*Based on 1975 average of 222.84 workers per million tons produced.

**Based on 1975 average of $7,742 per worker per annum, 1967 constant dollars.

***Based on Bureau of Mines estimates of 6.155 jobs generated for each new job in the phosphate industry.

****Average of $4,228 per worker per annum, 1967 constant dollars.

†U.S. Bureau of Mines (1975) adjusted by Texas Instruments for the study area; Florida Statistical Abstract (1976).

‡U.S. Bureau of Mines (1977) adjusted by Texas Instruments.

‡‡Texas Instruments projections of production from existing mines.

#To estimate total projected impact, effects from constant employment of about 3,000 chemical processing plant employees must be added.

waterborne commerce. Major plans are now underway to improve Tampa Harbor. A major part of the economic justification is the favorable economic impact expected on phosphate shipments. Tampa is a major port and vital to the economics of Florida as well as the nation. On a total tonnage basis, it is now the fourth largest export port and the eighth largest U.S. port. Annually, it handles more than 40,000,000 tone (36.3×10^6 metric tons) of commerce valued at more than $490,000,000. Its export exceeds 11,000,000 tons (10×10^6 metric tons) valued at more than $172,000,000. Phosphate shipments represent 97 percent of the port's outgoing cargo, and sulfur for the phosphate fertilizer industry represents an almost equal percentage of incoming cargo. In the 8-county area around Tampa Harbor, one in every seven wage-earners is employed by port-related businesses; this amounts to more than 36,000 workers and an annual payroll exceeding $210,000,000. Without the scheduled harbor improvement and concomitant increased phosphate industry shipments and receipts, the port could decline in importance, reflecting adversely on the regional economy and ultimately changing the character of current development.

Prohibiting development in wetlands will exclude from development an estimated 5000 hectares (12,300 acres) during 1977-85 and 10,890 hectares (26,900 acres) between 1977 and 2000. Under Scenario 2.11 (the "industry view'), which would permit all mine applications, an estimated 5000 hectares (12,300 acres) and 13,800 hectares (34,100 acres) of wetlands would be excluded in the respective time periods. However, since mining activities are expected to merely shift to lands not classified as U.S. waters or wetlands and since sufficient reserves exist within the study area to accommodate the required shift in mining operations between now and the year 2000, such exclusions will not materially affect production tonnages previously estimated for the two time periods under Scenario 2.11. Also, since no new chemical-plant construction between now and the year 2000 is projected, there would be no impact due to the recommended effluent standards for new-source chemical plants.

4. Resource Use

Phosphate industry activities that affect the area's natural resources focus on depletion of not only phosphate but uranium (which is mined concurrently), recovery, and, to a lesser extent, timber.

a. Phosphate Recovery

Phosphate resources of the area are estimated to be 1561.9 x 10^6 metric (1772 x 10^6 short) tons; 940.6 metric (1037 x 10^6 short) tons are classified as known reserves. Under Scenario 2.15, it is forecast that 327.4 x 10^6 metric (361 x 10^6 short) tons will be mined during 1977-85 and 537.9 x 10^6 metric (593 x 10^6 short) tons from 1977 through 2000. This represents a reserves depletion of 34.8 and 57.2 percent respectively.

The study area's total phosphate resources have been estimated to be 1596 x 10^6 metric (1722 x 10^6 short) tons, including known reserves totaling 940.6 x 10^6 metric (1037 x 10^6 short) tons. Phosphate ore to be mined under this scenario is estimated at 0.444 billion metric (0.489 billion short) tons during 1977-85 and 0.925 billion metric (1.020 billion short) tons during 1977-2000 (Table 3.8). Compared with the "Without Action" scenario, total tonnage mined under this scenario represents an increase of 35.5 percent for the short term and 72.0 percent for the long term. Conditions consistent with the "industry view" (Scenario 2.11') would increase production over the "Without Action" scenario by an estimated 35.5 percent by 1985 and 127.8 percent by the year 2000. In terms of depleting the area's known phosphate resources, this scenario poses an increase over the "Without Action" alternative of 7.5 percent in the near term and 24.8 in the long term; for Scenario 2.11', the increased depletion percentages would be 7.5 and 44.1 percent, respectively.

Table 3.8. Phosphate Rock Production Forecast for Scenarios 2.15, 2.11, and 2.11'

Scenario	Tons Mined x 10^6		% of Resources*		% to 2.15**	
	1977-85	1977-2000	1977-85	1977-2000	1977-85	1977-2000
2.15	361	593	20.9	34.4	–	–
2.11	489	1,020	28.4	59.2	7.5	24.5
2.11'	489	1,351	28.4	78.5	7.5	44.1

*Resources = 1,722 x 10^6 short tons (Reserves = 1,037 x 10^6) short tons).

**Change in percentage value relative to Scenario 2.15.

Clay slimes from washer plants contain phosphate, which ranges from about 10 percent BPL (bone phosphate of lime) to about 32 percent BPL and at present is not recovered (Table 3.9). Also, clean, uniform-sized sand from the flotation plant accumulates. Both materials technically qualify as resources, although the local market for the sand is virtually nonexistent, and the technology for recovering the phosphate from slimes has not yet been proved practical.

The predominant disposal practice used currently results in separate storage for the two materials, an act that would facilitate future recovery if technology/cost aspects of production and/or market benefits justified such recovery. On the other hand, the sand/clay mix process modification would reduce the "availability" of these materials, complicating eventual recovery.

It is estimated that 24,000 hectares (nearly 60,000 acres) of slime ponds and up to 6500 hectares (about 16,000 acres) of land containing the predominantly clean sand tailings currently exist as potential resources in the study area as a result of current and past phosphate mining and beneficiation.

Table 3.9. Phosphate Balance Sheet (Proportions of Recovered and Waste Products) for Study Area*

Percent BPL† in Matrix, Recovered Products, or Waste	Gross Wt [metric (short) tons]		BPL Contents [metric (short) tons]		BPL Contents (% of total)
Phosphate matrix (36%)	90.72	(100.00)	32.7	(36.0)	100.0
Coarse pebble (72.0%)	1.68	(1.85)	1.2	(1.3)	3.7
Medium pebble (72.0%)	2.99	(3.30)	2.2	(2.4)	6.6
Fine pebble (72.2%)	3.27	(3.60)	2.4	(2.6)	7.2
Total pebble (72.2%)	7.94	(8.75)	5.7	(6.3)	17.5
Coarse flotation (75.0%)	5.35	(5.90)	4.0	(4.4)	12.2
Fine flotation (76.0%)	13.61	(15.00)	10.3	(11.4)	31.7
Total flotation (75.8%)	18.96	(20.90)	14.3	(15.8)	43.9
Waste tailings‡ (9.0%)	33.24	(36.65)	3.0	(3.2)	9.0
Slimes, plus 200 mesh (27.4%)	9.98	(11.00)	2.7	(3.0)	8.4
Slimes, minus 200 mesh (34.8%)	20.59	(22.70)	7.2	(7.9)	21.9
Total slimes (32.4%)	30.57	(33.70)	9.9	(10.9)	30.3
Grand total	90.70	(100.00)	33.0	(36.2)	100.7

* U.S. Bureau of Mines 1975.
† BPL = bone phosphate of lime or tricalcium phosphate [$Ca_3(PO_4)_2$].
‡ Tailings from flotation treatment.

For effects assessment, however, these are considered to be tertiary resources. Furthermore, it is not anticipated that any significant recovery of phosphate values contained in the slime ponds will be affected during the period through 2000 because of the availability of sufficient reserves of minable rock in the area or that there will be any significant market for the waste sand. Also, the potential elimination of these materials from secondary recovery by implementing the sand/clay slime-mix technique for land reclamation appears to be significantly offset by the elimination of slime ponds per se as a potential environmental detriment. Thus, the impact of eliminating these tertiary resources is considered insignificant.

b. Uranium Recovery

It has been estimated that the 12 phosphoric acid plants in the study area annually pass 4.57×10^6 pounds (2.07×10^6 kilograms) of U_3O_8; assuming constant throughput, the amount available for recovery will approximate 41.1×10^6 pounds (18.7×10^6 kilograms) from 1977 through 1985 and 109.7×10^6 pounds

(49.9 x 10^6 kilograms) from 1977 through 2000. Assuming a constant price of $40 and a recovery cost of $15 per pound, the rank benefit of recovery would approximate $1.03 billion for 1977-85 and $2.74 billion for 1977-2000. The bulk of the mineral extracted along with the phosphate leaves the area through phosphate products shipped. Implementing the process modification will not affect the uranium resources of the area. The effects and impacts of implementing full-scale uranium recovery will center on economic values.

c. Fluoride Recovery

Since reported costs of recovery exceed the prices by 25-36 percent, fluorides are not considered at this time to be an economic mineral resource of the area.

d. Timber

Clearing land before mining involves the total removal of vegetation, including marketable timber. It is estimated under this scenario that approximately 3056 hectares (7552 acres) of land mapped as forest land will be mined during 1977-85 and 4843 hectares (11,968 acres) between 1977 and 2000.

The 7-county study area possesses approximately 69,650 hectares (172,100 acres) of forest land. The amount of commercial timber contained in this forest area is unknown; however, the majority of productive timber lands in Florida are located in National Forests outside the study area. A negligible amount of productive timber land will be lost as a result of phosphate mining. The forested lands within the 7-county study area are best described, then, as predominantly wildlife habitat, with some used for recreational resources and commercial timber.

It is estimated that the proposed action will result in disturbance of 3966 hectares (9800 acres) of forest lands during 1977-1985 and more than 7366 hectares (17,200 acres) from 1977 through the year 2000 - an increase of 53 percent over the "no action" alternative.

SECTION 4

SUMMARY OF SECONDARY IMPACTS OF THE PROPOSED ACTION

A. NATURAL ENVIRONMENT

1. Land

a. Soil

Secondary effects of phosphate industry activities on soil are restricted primarily to chemical alteration due to the stacking of materials (e.g., wet rock and gypsum). Water percolation through these materials tends to cause them to leach and be subsequently deposited in the soil underlying horizons. No secondary impacts could be determined for the various scenarios because of the lack of any quantitative model with which to assess the effects of leaching. The number of gypsum stacks is assumed constant among scenarios, but new wet rock storage piles are anticipated under the proposed action.

b. Radiation

There are four potential pathways for secondary impacts of exposure:

- Air contamination by radionuclides associated with dust created when dry phosphate rock and phosphate products are transferred.
- Possible contamination of ground waters by seepage of process waters at the chemical plants and slime-pond waters in the mine areas
- Radon-222 daughter-product contamination of air in structures built on land previously mined by the industry
- Consumption of foods (crop foods or beef) produced on reclaimed land

Of these, the most significant is considered to be exposure from radon-222 daughter radionuclides in homes or other structures built on reclaimed land.

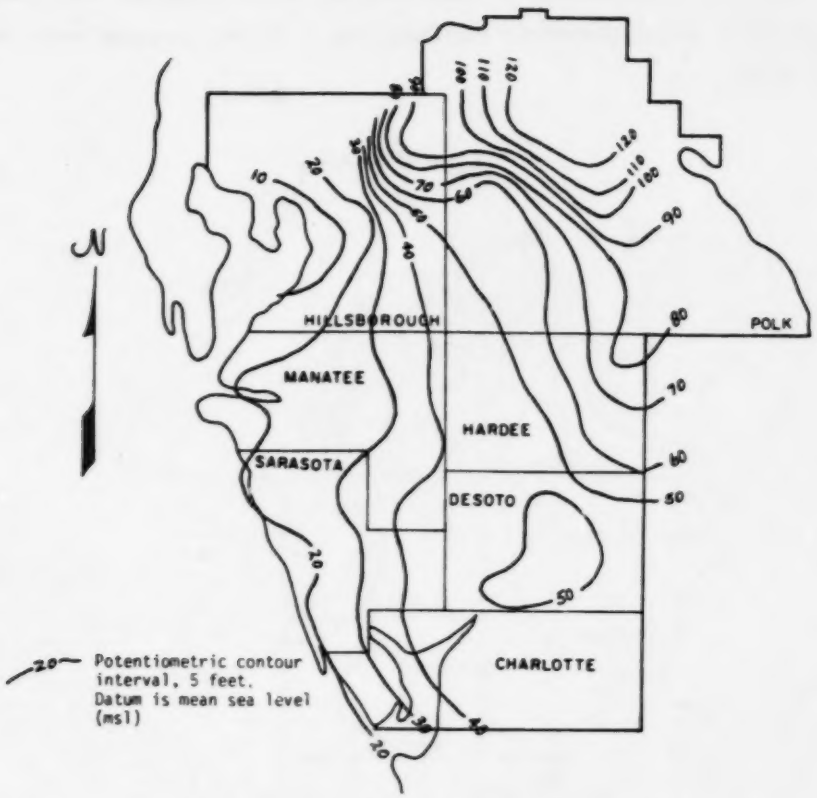
c) Terrestrial Biota

Among possible secondary effects not implied in the discussion of primary effects are certain changes occurring in coastal areas as a result of mining. For example, if the harbor area were increased to accommodate the transportation of phosphate rock or other materials, it could affect terrestrial biota; however, the expected changes (e.g., the deepening of Tampa Bay), will have little effect.

2. Water

a) Quantity

Pumping from the Floridan aquifer will (1) decrease streamflow, affect surface vegetation, and possibly affect lake levels and (2) cause upconing of highly mineralized waters from the deeper parts of the Floridan aquifer and lateral encroachment of salt water from the coastal zone. Unfortunately, a basic assumption used in the design of the model is a constant head in the water table aquifer, so the model cannot predict declines in the water table as a function of pumping from the Floridan aquifer; therefore, very little can be said of the effect on the vegetation and surface-water systems as a result of pumping from the Floridan aquifer. One aspect that can be evaluated indirectly, however, is the potential for saltwater encroachment in relation to the change in the potentiometric surface. For example, the 1985 potentiometric surface map (Figure 4.1) that was simulated by combining the September 1975 potentiometric surface and the predicted water-level changes under Scenario 2.15 in the year 1985 showed no change in the location of the 20-, 30-, and 40-foot contour lines in the coastal zone. Thus, it may be concluded that the gradient in the potentiometric surface has not changed, nor has the outflow of fresh water to the coast from the Floridan aquifer.



NOTE: Contours reflect September 1975 surface modified by changes in phosphate industry withdrawal rates only.

Figure 4.1. Simulated Potentiometric Surface, September 1985, under Scenario 2.15

The sharp rise in water levels in Polk County will provide an economic benefit to owners of wells in those areas because pumping costs will be reduced. Although there are no data showing real potentiometric surface countours that would reflect municipal, agricultural, and industrial pumpage, it is clear that completion of existing phosphate mining operations will have a beneficial effect on the water resources of the study area.

To assess the worst-case (Scenario 2.11') secondary effects on the hydrologic system, a potentiometric surface map for September 1985 was prepared (Figure 4.2) by combining calculated water-level changes for that period with a September 1975 potentiometric surface map. These changes were calculated using the USGS model.

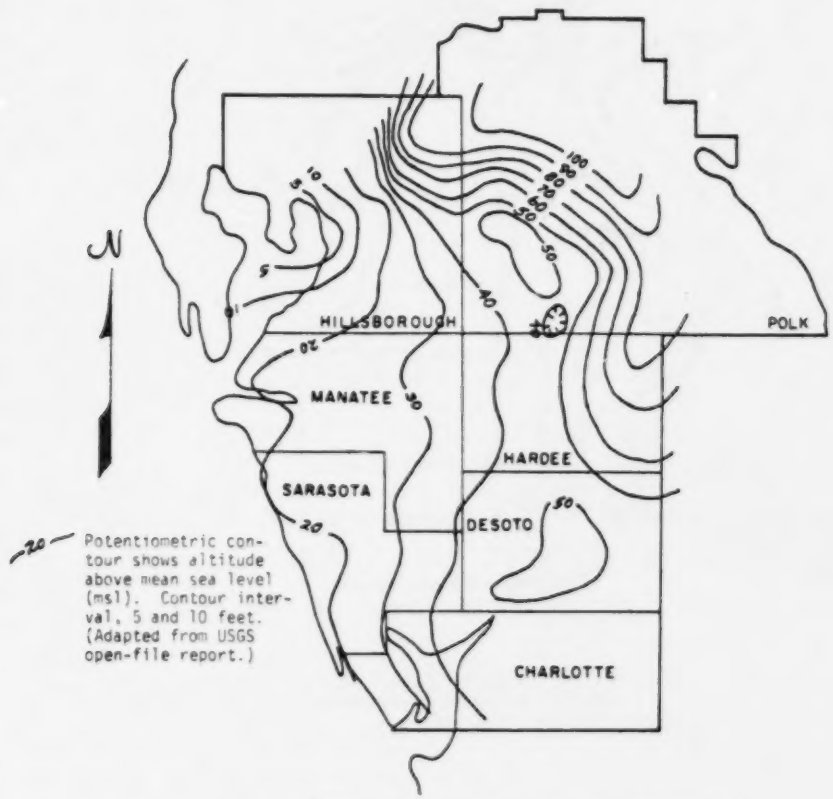

N
HILLSBOROUGH
POLK
MANATEE
HARDEE
SARASOTA
DESOTO
CHARLOTTE
-20- Potentiometric contour shows altitude above mean sea level (msl). Contour interval, 5 and 10 feet. (Adapted from USGS open-file report.)
NOTE: Contours reflect September 1975 surface modified by changes in phosphate industry withdrawal rates only.

Figure 4.2. Simulated Potentiometric Surface September 1985, under Scenario 2.11'

The 20-foot contour will be in the same location in the coastal zone in September 1985 as it was in September 1975 indicating that no change in the potentiometric surface will have occurred in the coastal area. The 30-foot contour line will have moved farther to the east, thereby creating a somewhat large spacing between the 20- and 30-foot contours. This indicates a flattening of the gradient of the potentiometric surface toward the coast, suggesting a decrease in groudwater flow toward the Gulf of Mexico. In southwestern Polk

County, water levels will rise 10 feet in certain areas, thereby reducing the pumping lift for many wells and subsequently resulting in an economic benefit to the owners of the wells.

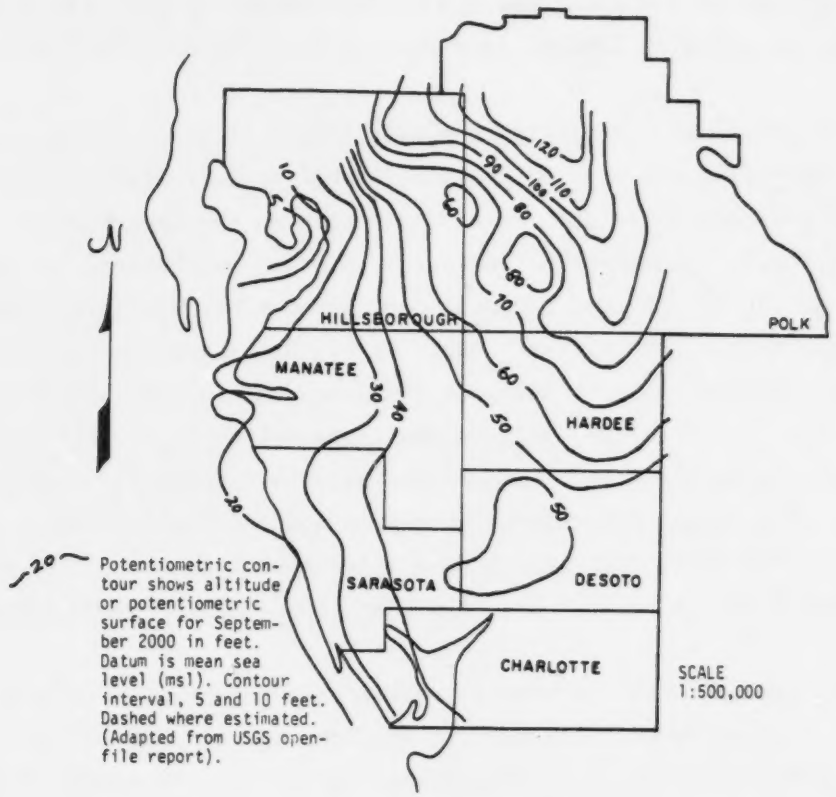


Figure 4.3. Simulated Potentiometric Surface, September 2000, under the "Without Action" Alternative

On the potentiometric surface map for the year 2000 (Figure 4.3), contours in the coastal zone are more closely spaced that in 1975. More specifically, the 20-foot contour line is still at the same location but the 30-foot contour line has moved somewhat to the western part, followed by the 40-foot contour line. This means that the elevation of the potentiometric surface in the coastal zone will have increased by the year 2000, thereby most likely increasing the outflow of fresh ground water to the Gulf. This will reduce the potential for lateral saltwater encroachment. Apparently, because of Scenario 2.15, more water will be lost to the Gulf in the year 2000 than was lost in 1975

In Hardee County, there will be a positive effect: the area encompassed by the 50-foot contour will increase considerably, indicating that the water level has risen in those areas. This rise will have a beneficial secondary effect inasmuch as well-owners in the area will be spending less money on pumping because pumping lifts will have decreased.

As mentioned previously, the model has a constant source and does not predict changes in the head of the water-table aquifer itself. Therefore, the impact of proposed phosphate mining activities on the water table and on water-dependent vegetation cannot be assessed. However, experience has indicated that the effects can be expected to be minimal because the confining beds are relatively impermeable and thicken toward the south. An adverse economic effect of the proposed development in Sarasota, Manatee, and to some extent in southern Hillsborough County in 1985 will be the increased costs to well-owners because of increased pumping lifts. Also, there will be increased potential for upconing of mineralized water from the deeper zone of the Floridan aquifer, especially in old wells that have been drilled into the lower, more mineralized zone of the Floridan aquifer and have been abandoned without being plugged.

In regard to the problem of saltwater encroachment in the coastal zone, the flattening of the hydraulic gradient between the 20- and 30-foot contours suggests a reduction in groundwater outflow and, theoretically, an increase in the potential for landward movement of the salt/freshwater interface.

The potentiometric surface of the Floridan aquifer for September 2000 (Figure 4.4) was constructed by using the September 1975 potentiometric surface map in combination with water-level changes between 1975 and 2000. There will be some changes in the inner parts of the Central Florida Phosphate District and, again, shifts will be in the location of the 20-foot contour in only a few places along the coast. The 30-foot contour line, however, will move farther eastward and be in the western part of Hardee County near the town of Ona. In eastern Manatee County, the potentiometric surface will have a plateau-like appearance, as shown by the 20-foot contour line. The flattening of the potentiometric surface will reduce groundwater outflot toward the Gulf, and this most likely will increase the potential for the inland movement of the salt-/freshwater interface. There will also be an economic effect, because the reduction in the potentiometric surface will result in increased pumping lifts and costs in certain areas.

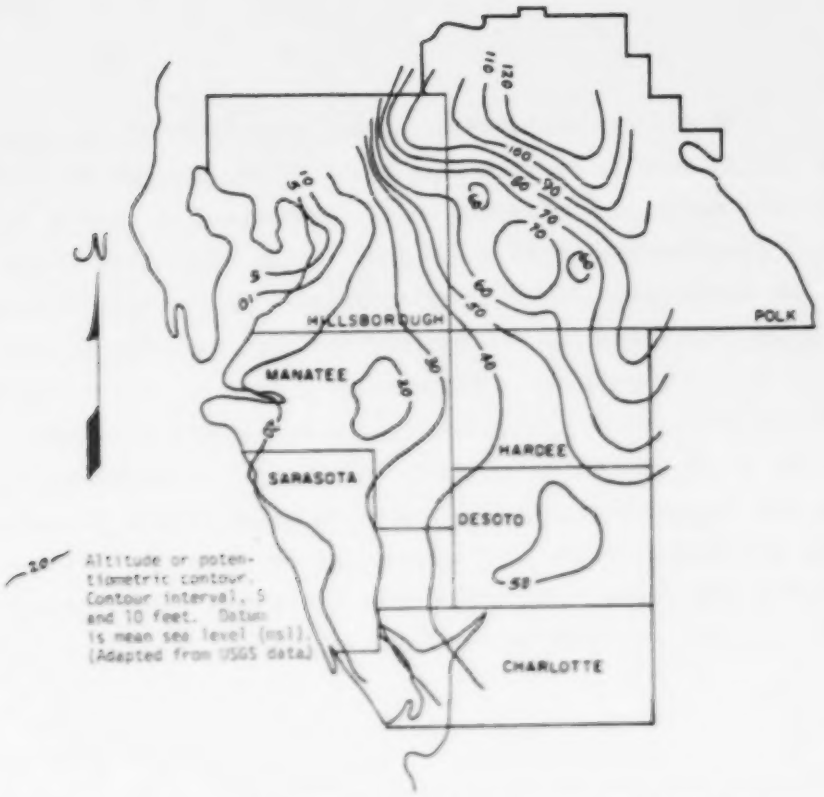

HILLSBOROUGH
POLK
MANATEE
HARDEE
SARASOTA
DESOTO
CHARLOTTE
-20- Altitude or potentiometric contour. Contour interval, 5 and 10 feet. Datum is mean sea level (msl). (Adapted from USGS data)
NOTE: Contours reflect September 1975 surface modified by changes in phosphate industry withdrawal rates only.

Figure 4.4. Simulated Potentiometric Surface, September 2000, under Scenario 2.11'

In summary, future development of the phosphate industry under Scenario 2.11' will generally lower the potentiometric surface of the Floridan aquifer in the western part of the Central Florida Phosphate District, but the predicted declines will be very small compared with the total thickness of the freshwater zone (a 10-foot decline compared with a thickness of 1500 feet). No adverse effects except the small increase in pumping costs and the increased potential for saltwater encroachment are expected from future pumping of the Floridan aquifer by the phosphate industry. The validity of these predictions, of course, depends on the validity of the water-level changes predicted from the aquifer model designed and constructed by the U.S. Geological Survey.

The difference between the two scenarios' (2.11; and 2.15) effects on the potentiometric surface will be, at most, 20 feet at the Manatee-Hardee county line north of the Myakka head. Comparison of this value with average seasonal fluctuations of 30 to 40 feet in the area leads to the conclusion that a 20-foot difference is not a major effect. To estimate the economic difference between the two scenarios, it was assumed that the cost of lifting 1 acre-foot of water (325,900 gallons) a distance of 1 foot is 2.6¢ for a pump working at 80 percent efficiency. For example, the difference in economic costs to pump at a rate of 10,000,000 gallons per day in the northeastern corner of Sarasota County was calculated: the difference in water levels is approximately 7.5 feet and the difference in the cost of lifting the water is $2184 per year (the year 2000); the annual cost difference for a well-owner pumping at the same rate in the area north of Myakka head is $5824.

b) Quality

Secondary effects on water quality were taken to be potential effects. These potential effects are salt-water encroachment due to drawdown of the Floridan aquifer; contamination of the water-table and Floridan aquifers by seepage from contaminated ponds, which causes sinkholes that collapse and allow direct contamination; and radiation potential because of gyp ponds and mining-pit reclamation.

A secondary effect under the conditions of the proposed action is the increased potential for pollutional loads from failure of slime-pond dikes. This potential is particularly significant since, under this scenario, a slime-pond break would threaten the water quality of Class-I waters.

c) Biological

The phosphate industry's secondary effects on the aquatic biota of the study area involve waste discharges on receiving waterbodies, the potential for spilling hazardous materials at processing plants, and impacts of supporting activities such as electricity generation and transport (shipping). The effects of all except waste discharges are considered to be minor.

Industry discharges of high concentrations of inorganic nutrients (nitrogen and phosphorus), coupled with naturally high ambient concentrations in flowing waters of the study area, result in highly fertile water supporting rich and diverse running-water communities. Extremely productive estuarine communities occur at the mouths of the Peace and Alafia rivers where the fertile river water enters the estuary; indeed, the unusually high productivity of both Tampa Bay and Charlotte Harbor can be attributed largely to significant contributions of inorganic nutrients by the major contributing streams (Alafia and Peace, respectively). Waste discharges can be detrimental locally (e.g., toxic concentrations of ammonia), and, though sometimes beneficial, nutrient enrichment can potentially result in severe nuisance hydrophyte problems and degradation of habitat quality in the rivers and estuarine systems.

B. MAN-MADE ENVIRONMENT

Development of Tampa Harbor and development of the phosphate industry are synergistic: development of one presumes development of the other; and conversely, if one is not developed, the other is not likely to be developed. Perhaps not readily apparent to the casual observer, the bulk of employment in the Tampa area is in manufacturing, construction, transportation, and communications - and the harbor (largely supported by phosphate industry shipments) contributes directly or indirectly to all these industries. Many important industries need the harbor facilities but are not important enough to support them. An example is the Disney World complex near Orlando, one of the major contributors to increased demands for products through Tampa Harbor. New industries such as optical materials and gun manufacturing, construction of prefabricated houses, assembly of foreign trucks imported through the harbor, export of citrus fruit, and processing of food caught off Florida's coast depend on a viable harbor system. Failure to develop the harbor would cause a decline in the operations.

Attention is invited to previous comments on effects under the "Without Action" alternative in Volume II of the FEIS. Accelerated phosphate mining could increase already inflated land values, deplete nonrenewable resources, and further reduce the amount of land in agricultural production. Adverse environmental damage such as despoiled landscapes or incompatible land usage could result.

Industry holdings of land will effectively prevent large-scale development of the held land for at least the next 25 years. This reclaimed land will then be available for phased development at a time when it is most needed to relieve coastal population congestion.

Table 4.1 projects by scenario the economic impact of the phosphate industry on the study area. As indicated, the industry's continued development will result in about 10,000 direct and almost 62,000 induced jobs in the study area by 1985, declining to about 8100 direct jobs and 50,000 induced jobs by 2000. Total payroll attributable to the phosphate industry will be about $340,000,000 in 1985, declining to about $274,000,000 by 2000.

Table 4.1. Projected Economic Impact of Phosphate Industry on Study Area by Scenario, 1980-2000

Year	Scenario	Production (million short tons)	Phosphate Industry Employment*	Phosphate Industry Payroll** (000,000)	Induced Employment***	Induced Payroll**** (000,000)
1975	Actual†	38.2	8,512	65.8	52,349	221.3
1980	2.11‡	41.2	9,181	71.0	56,463	238.7
	2.15‡	42.2	9,403	72.7	57,828	244.4
1985	2.11‡	45.2	10,072	77.9	61,943	261.9
	2.15‡	33.2	7,398	57.2	45,498	192.4
1990	2.11‡	44.8	9,983	77.2	61,395	259.6
	2.15‡	27.5	6,128	47.4	37,687	159.3
1995	2.11‡	42.0	9,359	72.4	57,558	243.4
	2.15‡	9.1	2,028	15.7	12,472	52.7
2000	2.11‡	36.5	8,133	62.9	50,017	211.5
	2.15‡	2.6	579	4.4	3,560	15.0

*Based on 1975 average of 222.84 workers per million tons produced.

**Based on 1975 average of $7,742 per worker per annum, 1967 constant dollars.

***Based on Bureau of Mines estimates of 6.155 jobs generated for each new job in the phosphate industry.

****Average of $4,228 per worker per annum, 1967 constant dollars.

†U.S. Bureau of Mines (1975) adjusted by Texas Instruments for the study area; Florida Statistical Abstract (1976).

‡U.S. Bureau of Mines (1977) adjusted by Texas Instruments.

‡Texas Instruments projections of production from existing mines.

SECTION 5

AVAILABLE MINIMIZING AND MITIGATIVE MEASURES FOR THE UNAVOIDABLE ADVERSE IMPACTS OF THE PROPOSED ACTION

A. ATMOSPHERE

Potential impacts to air quality as a result of pollution control equipment breakdown can be minimized by installing alarm and plant-shutdown systems and procedures. To assure company operation and maintenance programs that address the efficient operation of pollution control equipment, the following program of surveillance by the state is recommended:

Air Program

- In-plant inspections
  - Inspect all air pollution control equipment semiannually (minimum) for operational ability and condition.
  - Make unannounced inspections of specific equipment at any time.
- Source inspections
  - Witness all company stack tests for compliance with permit conditions. (Phosphate companies are currently required to perform stack tests semiannually.)
  - Maintain one full-time DER stack-sampling team to monitor compliance.
- Ambient air-monitoring program
  - Establish a regional network of ambient air-monitoring stations based on modeling of known sources and continually updated as new sources are built. (Present program consisting of five stations probably will have to be expanded.)
  - Sample on a 6-day, 24-hour basis.
  - Sample fluorides, sulfur dioxides, and particulates.

- Ambient vegetative-fluoride sampling program
  - Establish a regional network of vegetation sampling locations based on modeling data.
  - Sample primarily pasture grass, citrus leaves, and gladiolas and include other vegetation as necessary. (Present program consist of approximately 13 pasture-grass stations. Sample locations need to be reviewed and quantity possibly increased.)
  - Sample once per month.
  - Monitor fluorides.

B. LAND

Mining disturbs existing land cover, changes land use, and redistributes soil and radioactivity. Even with the proposed action, which incorporates measures to minimize such impacts, there will be alterations in wildlife habitat and changes in land use through the remainder of this century. These impacts can be minimized and mitigated through the remainder of this century. These impacts can be minimized and mitigated by thoroughly planned mining and reclamation that incorporates the complete life-cycle of use before, during, and after mining activities. Land-use plans must reflect needs projected beyond reclamation and incorporate fish and wildlife values by leaving some pits for reclamation by natural processes and by assuring a mixture of surface-water storage, meandering streams, vegetated floodplains, and forested uplands.

Since the proposed scheme for regulating wetlands development is not yet defined by area or distribution, the impacts described are based on the protection of wetlands depicted in the USGS LUDA maps. As the areas representing the three categories of regulatory prohibition are defined and mapped and permits granted in accordance with the proposed action, wetlands restoration technology as well as management practices during mining will become particularly important. These concerns must be addressed in the site-specific environmental assessments and/or impact statements.

There should be provisions to preserve archeological and historical sites. An assessment survey of site-specific areas should be conducted to locate and identify significant site remains. These efforts should be coordinated with the Florida Division of Archives, History, and Records Management.

Specific actions required by proposed administration of the federal Surface Mining Control and Reclamation Act of 1977 (PL 95-87 as reported in the Federal Register [42 FR 44920], 13 December 1977) deserve consideration as measures to apply to the strip-mining of phosphate in westcentral Florida. They are as follows:

- Return land to "approximate original contour."
- Return land to use prior to mining or to a land use compatible with the surrounding area.
- Stockpile topsoil (A horizon) during mining and return as the surface layer during reclamation.
- Commence reclamation within 1 year of initial disturbance in any given area.
- Plant initial vegetation that stabilizes the surface, then plant species of vegetation that existed prior to mining.
- Assure reestablishment of surface and groundwater hydrology systems that existed prior to mining.
- Designate areas such as critical wildlife habitat "unsuitable for mining" and prohibit mining in those areas.

C. WATER

Risks of deterioration of surface-water quality because of spills and dam breaks will continue to be of concern as the phosphate industry extends operations to new areas of westcentral Florida, but efficient operation and maintenance of pollution control equipment will assure that impacts are limited to those described.

1. Spills

The probability of potential spills from pipeline breaks, tank ruptures, and rail or truck accidents at the chemical plants can be minimized by routing plant runoff through containment areas and by using pH monitors and alarm systems such as those currently in operation at existing chemical

plants in the area. System monitoring should be complemented with once-per-shift manual sampling to ensure that the automated equipment is efficiently operating.

At the mining and beneficiation sites, planning matrix and slime pipeline routes to assure containment of spills would minimize the risks and potential adverse impacts from breaks. Additionally, alarm systems would alert operators of pressure drops and automatically activate shutdown systems along sections of pipelines in case of ruptures or pump breakdowns.

2. Dam Breaks

Only one gypsum-pond dam break has been experienced at a chemical plant in central Florida, and there have been none since 1965. However, the potential will continue to exist, calling for continued diligence through inspection. It is recommended that the Florida Department of Environmental Regulation supplement the existing inspection program with periodic inspections by state employees.

The potential for dam breaks will still be present from new-source mines because of implementation of methods to reduce slime disposal. The initial slime-holding area and any settling areas resulting from an excess of slimes that can be handled with available technology must be constructed to ensure integrity and periodically inspected to minimize the risk of breaks. As with gypsum-pond dams, state programs for design, construction, inspection, and maintenance need to be supplemented with monthly regulatory-agency inspection.

D. RECOMMENDED STATE SURVEILLANCE PROGRAM

Water Monitoring Program

- In-plant inspections
  - Inspect major water-pollution abatement equipment semiannually.
- Source sampling or monitoring
  - Sample chemical-plant dischargers monthly. (Analyze as a minimum for fluorides, phosphorus, flow, nitrogen, and pH.)

- Sample mining discharges quarterly. (Analyze as a minimum for flow, suspended solids, phosphorus, fluorides, and pH.)
- Annually perform composite sampling of all dischargers.

• Ambient water-monitoring program

- Monthly sample major streams downstream from all phosphate industry dischargers. (Analyze for PNS parameters.)
- Sample quarterly the receiving waters at optimum locations downstream from the dischargers.
- Annually sample receiving streams upstream from phosphate-company dischargers.

Dam-Inspection Program

- Make unannounced inspections of company dams and company maintenance and inspection program to see that they comply with the DER Chapter 17-9 requirements.

E. GENERAL ADMINISTRATION

When combined with Federal permitting actions, the State Development of Regional Impact (DRI) Application for Development Approval (ADA) process can serve as an integrating approach to discerning impacts of new phosphate industry activities and defining options available for management or avoidance of those impacts. The DRI/ADA process receives attention by local and regional agencies, as well as State agencies and thus, when inventigations and reports resulting from the process address Federal requirements, then an overview of actions by all levels of government is provided. Such an overview will aid participants in the permitting process in identification of compatible and conflicting government actions.

SECTION 6

SHORT-TERM USE VERSUS LONG-TERM PRODUCTIVITY

Creating strip pits and waste-disposal areas, disrupting natural soil characteristics, and redistributing radioactive materials are phosphate industry activities that have direct adverse impacts and also present risks of further impacts due to accidents. The tradeoffs are low-priced fertilizer for enhanced agricultural production; local and regional economic activity; employment and tax revenues; and reduction in U.S. trade deficits. The economic gains and associated activities as the industry locates in new areas of westcentral Florida will be accompanied by public anxieties about pollution, health, noise, wildlife disturbance, and visual aesthetics - but these impacts will be offset in the long term as public knowledge of phosphate operations and regulatory-agency activities increases and broadens and as the requirements of the proposed action are matched by the performance of the phosphate industry.

Reducing slime-disposal areas will reduce the near-term adverse impacts of the applied technology used in processing phosphate in westcentral Florida but increase reclaimed area over that created under present processing techniques. Thus, a greater number of acres will have a more restrictive set of options for subsequent uses than would exist if the application of present technology were to continue. Restrictions on land use may be more hypothetical than practical, whereas reducing the hazards and standing "stock" of slimes has real near-term advantages.

Holding wetlands from industrial development by the phosphate industry has near-term benefits, but it must be pointed out that the restrictions apply only to phosphate companies, not necessarily to subsequent owners (e.g., one that would use the land for agricultural purposes).

Continued and increased phosphate extraction and processing will result in more and larger gypsum stacks at the chemical plants. This waste-disposal problem is the most difficult facing the industry aside from clay slimes, and its resolution will require continued effort on the part of both industry and public agencies. Also, the continued extraction of phosphate

from westcentral Florida will shorten the time when future resources will need to come from other locations in Florida, the U.S., or the world; however, the time frame may be extended if more efficient processing (e.g., a technique recently announced by IMC) extracts a greater percentage of the phosphate values.

Continued economic productivity will be enhanced by the continued operation of the phosphate industry under the proposed action, but present mining and reclamation practices generally will cause land-use/land-cover types to shift from wildlife to human uses, decreasing habitat types and natural wildlife-community diversity.

SECTION 7

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

It is projected that mining in the study area will remove 945,000,000 metric (1.04 billion short) tons of phosphate rock through the year 2000. In association with the phosphate rock removal, 189,000 metric (208,000 short) tons of uranium will be removed. While the phosphate rock will be processed for useful purposes, all of the uranium except that recovered at phosphoric acid plants will be lost as a resource.

An irretrievable resource will be the fossil fuel necessary to generate the electricity needs of the phosphate industry (88 billion kilowatt-hours) between now and the year 2000. Also representing irretrievable commitments of resources although they are not resources of the study area are the chemicals that will be used in processing phosphate for fertilizer, sulfur, and ammonia. The sulfur now in chemical-plant waste stacks represents a presently uneconomical source.

Land-use changes caused by mining will narrow future land-use options, especially in reclaimed slime-pond areas. Of the 56,000 acres projected to be reclaimed by the year 2000, 52,000 acres would be reclaimed slime areas. The subsequent use of reclaimed slime areas is limited to activities in which overburden pressures are no greater than those that would result from agricultural production.

Archeological sites in areas mined will be destroyed. Artifacts may be recovered, but the sites will be lost.

Approximately 45,000 acres of uplands, including pine flatwoods that are important to most of the 12 threatened and endangered species susceptible to mining activities, will be replaced with managed systems.

SECTION 8

RESEARCH NEEDS

A. INTRODUCTION

The following studies have been identified as needed to further delineate effects of the central Florida phosphate industry on the environment. While results of these recommended studies probably will not affect the conclusions documented in this EIS, they are needed to assure that any adverse areawide and cumulative effects of the industry are ameliorated in an economical and efficient manner.

B. FLUORIDE EMISSIONS

To determine the quantity of fluorides emitted to the atmosphere from recirculated process water ponds (gyp ponds), a study is needed to establish a relationship between pond water chemistry, water temperature, air temperature (and possibly humidity), wind velocity, and fluoride emissions. This information would allow estimates to be made on quantity of fluorides emitted from ponds, and would also allow determinations to be made on optimum maintenance of pond water fluoride concentrations.

C. FLUORIDE EFFECTS ON BIOTA

As recommended by Mr. Archie Carr III, of the Florida Audubon Society, a study on the effects of fluoride emissions in Central Florida on native vegetation and wildlife is needed. Virtually all research done to date has been on cattle, citrus, and pasture grass.

D. HYDROGEOLOGY

Detailed hydrogeologic study is needed to determine extent of chemical and radiological contamination of the water table and the Floridan Aquifer by seepage from contaminated process water ponds.

E. WETLANDS

Research is needed into the questions associated with creation and restoration of wetlands.

F. POLLUTANT LOADING

Detailed wet and dry season water sampling surveys by DER and/or EPA are needed to better quantify pollutant loadings and effects of each individual existing chemical phosphate plant and mine.

G. SLIMES

Continued research on alternative uses of slimes, including recovery of phosphate values from slimes is needed. This may include additional research on direct acidulation of unslurried matrix. Recent uranium recovery processes may make direct acidulation more favorable than when it was tried and discarded several years ago.

H. RADIATION

Development of quantified radiation exposure data, and a program of long term monitoring of radiological effects on atmosphere, land, surface water, and groundwater.

SECTION 8

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